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ANIMAL WIND-BAGS—USEFUL AND ORNAMENTAL.

WIND-BAGS AND LOVE-DISPLAYS.

By W. P. PYCRAFT, A.L.S., F.Z.S., ETC

IT is astonishing, when one comes to reflect on the matter, how many and quite unrelated animals have adopted the same tactics, though by very different means, to gain some particular end, whereby they may obtain some advantage over their neighbours in the struggle for existence. Wind-bags or "air-sacs" of some sort or another seem to have been especially favoured. By their means the form of the body may be temporarily changed, thereby rendering the animal unlike its near allies, but superficially like that of some other creature or even inanimate object, or they may serve as voice organs, whereby their possessors may charm their mates, or strike terror into the heart of an enemy. Yet again, they may serve the purpose of a substantial banking account, and enable life to be got through with the least possible expenditure of energy.

These wind-bags, which, almost without exception, may be inflated and deflated at the will of the animal, differ much in the nature of their origin. In many cases they are formed by more or less extensively enlarging parts of the gullet or of the windpipe, without disturbing their normal functions. In others the air is drawn into special receptacles. Wind-bags of the latter type, however, have also been developed as auxiliary breathing organs, as in the case of birds, for instance. With these we have no concern here; their description awaits special treatment. In the present series of articles, of which this is the first, we propose to deal only with those air-sacs which are concerned with purely external phenomena.

The development of purely ornamental wind-bags, used as adjuncts in courtship, forms the theme of the present chapter. The most conspicuous and successful patrons of this form of display are to be found amongst the ranks of the highly excitable and always beautiful birds.

Thomson's assurance that "the lover is the very fool of Nature" seems particularly applicable to displays of this kind. Take the common pigeon for example. Could anything appear more silly than the strutting, bowing and cooing of the cock aided by this very practice of filling his gullet with intoxicating draughts of the morning air, the which swells his neck to unduly large proportions, and apparently, on this account, make him so much the more fascinating? But the past-master in the art of windy love-making among the pigeons is the domesticated variety known as the pouter.

As with the pigeon tribe, no special receptacle is provided for the indrawn air, but that portion of the gullet known as the crop has been enormously enlarged so that, when fully inflated, it exceeds the body itself in size. The present greatness of this crop, we would point out, is due not so much to the efforts of the prancing bird as to the care and selection of the breeder. For this display, strangely enough, has found favour even among men; consequently, the very finest performers only are selected to be the parents of the next generation, and these parents are themselves, of course, descendants of equally distinguished birds. The part the breeder has played has been to select carefully from his young birds those which prove the best performers. From these he raises new stock. Their unskilled kindred go to make pigeon pie, or meet some other ignoble fate.

A still more remarkable gullet pouch is that of the frigate-bird of the Tropics; a near ally of the cormorants and gannets. Bare externally, of a vivid scarlet colour, and capable of being inflated till it is nearly as large as the rest of the body, this pouch is an invaluable asset to its possessor when seeking a mate. For here, as elsewhere, the successful suitor is he who makes the most of his peculiar charms; the prize falling to him who is able to display the biggest and most brilliantly coloured pouch. Only the males wear this ornament, which is retained only during the breeding season. At this time a lively competition appears to take place, a dozen or so of these birds crowding together in a tree and greeting the approach of their prospective mates with inflated pouches and drooping wings, accompanied by a peculiar apology for a song, described as a sort of "wow-wow-wow-wow," and a noise resembling the sound of castanets, which is made by a violent chattering of the horny beak.

The pouch of the frigate-bird is formed by the upper end of the gullet, and appears to be closed behind by a peculiar arrangement of muscular fibres to form what is known as a sphincter muscle. These muscles close up the tube of the windpipe much as the mouth of a bag is closed by means of a double string.

The American prairie-hen, or pinnated grouse, has long

been celebrated for its remarkable love display. Collecting in small parties of both sexes, the males come forward and perform a series of strange evolutions, in which a pair of sacs, one on either side of the neck, play a conspicuous part. When the bird is quiet these sacs or bags are hidden by the feathers, but during the paroxysms of excitement they are inflated so as to form a pair of huge bladder-like organs, of a bright orange colour. As soon as these pouches are filled certain elongated feathers of the nape of the neck are shot forwards, the wings are trailed upon the ground like those of the turkey-cock, and the body, with the feathers bristling like the quills of the fretful porcupine, is inclined forwards. Suddenly the bird starts to run, rushing in among the amazed females and giving voice at the same time to a loud booming noise, audible, on a still morning, for a couple of miles. Then follows a momentary period of quietude, and the process is repeated. Sometimes as many as twenty cocks take part at a time in these displays.

The depletion of our British bird-fauna which has taken place during the last fifty years has robbed us at one fell stroke of our largest British bird, as well as the only nember thereof which boasted a true ornamental air-sac. This was the great bustard To witness the display of this bird in a wild state to-day one must travel to Spain. To the bird-lover the journey is well worth the making, for a more wonderful, and at the same time a more grotesque sight, would be hard to find, since the inflation of its wind-pouch is accompanied by the art of the contortionist.

Approaching his mate with a series of short, mincing steps, he next proceeds to throw his tail forwards so as to lie flat upon his back, where it is held down by the long quills of the wing. Thus he contrives to display a magnificent, billowy mass of white feathers which normally lie under, and are concealed by the tail. Next he ruffles up the feathers of the back and wings in such a way that certain feathers forming the inner lining of the wing are brought prominently into view; these also are white as the driven snow. Finally the head is thrown back, and the wind-pouch or air-sac as it is called, is inflated to an enormous size, almost burying the head therein This done, the head is still further masked by the erection of a number of long feathers, which normally, when the bird is at rest, hang down like a long beard. Erected, they stand up on either side of the head like a palisade. What the general effect of such a display is like may be gathered from the annexed picture.

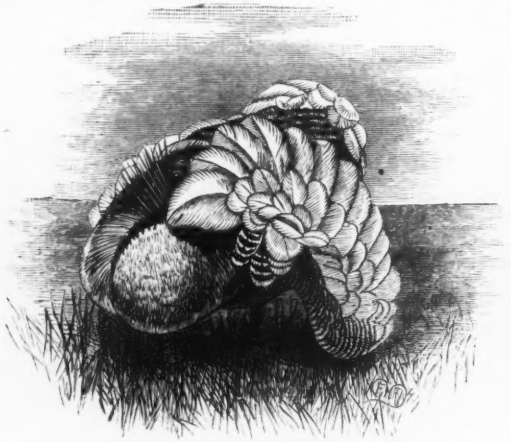

FIG. 1.—The display of the Great Bustard, *Otis tarda*. (After Wolf.)
From the "Dictionary of Birds," *by* PROF. A. NEWTON.

This air-sac deserves further notice, for it is a peculiarly interesting structure both from an anatomical and a historical point of view.

Well known to the older naturalists, it was generally regarded by them as a receptacle for water, a view which gained colour from the fact that the bird frequented arid and sandy wastes where water was naturally scarce, so that the possession of a water-bottle seemed by no means a striking feature. This tradition, in more critical times, first became suspect by the discovery that the male only possessed the pouch. Further enquiry showed that not even all the males were so provided, and this led many to believe that the whole story of the existence of the pouch at all was a myth. If its use was to store water, they contended, it should be found in both sexes, since both would have equal need thereof. The fact that many adult male birds had been dissected without revealing the presence of a pouch seemed to confirm their doubts as to the probability of the story.

Later observation, however, has definitely settled the question. Careful dissection has proved the existence of the pouch, whilst the field naturalist has shown us its purpose, which turns out to be ornamental rather than useful.

Structurally, this air-chamber or wind-bag, as it proves to be, differs, as we have already hinted, from those which have so far been described, inasmuch as these have been formed simply by inflation of the food-pipe or gullet, whilst in the case of the bustard the chamber is an entirely independent structure. Extremely thin-walled, it extends from the base of the tongue down the front of the neck, immediately beneath the skin, to its base. In fully-developed examples this remarkable pouch is found to have a bulb-shaped termination, the which lies between the arms of the merry-thought. Air is admitted through a small hole at the base of the under-side of the tongue, and when the display of the proud performer is finished, the air is expelled again from the same aperture. During the display small quantities of air appear to be expelled for the purpose of producing a sound said to resemble the word "oak," possibly to attract the attention of the lady of his choice, who often affects an absolute indifference or even ignorance of the fantastic performance which is intended for her eyes alone.

Some doubt still exists as to whether this pouch is retained throughout the year, or whether, after the season of courtship, it becomes absorbed to be re-developed in the succeeding spring.

It seems but natural to suppose that the method of courtship displayed by the great bustard would be adopted by the bustard tribe in general. As a matter of fact, however, such is by no means the case. No other bustard has succeeded in attaining such a pitch of artistic display. The nearest approach thereto, perhaps, is that made by the giant Australian bustard, *Eupodotis australis*. But he has not the skill of his British cousin. His attitude at this time is distinctly "wooden." Throwing the tail upward and forward over the back, the neck is then stretched to its greatest length and held stiffly upwards, whilst at the same time great gulps of air are drawn into the gullet till a long pendulous and feather-clad bag is produced which hangs down considerably below the level of the breast. At the throat is a great bulbous swelling which causes the feathers in this region to stand on end, and thereby add to the effectiveness of the whole display. The attitude complete, the ardent swain stands motionless, mutely pleading for the approval of his prospective mate. Here again, be it noted, no special apparatus, no true air-sac or wind-bag has been produced. The same methods have been resorted to which are employed by the frigate-bird and

the pigeon. In the swollen throat we may get an inkling of the origin of the remarkable wind-bag of our British bustard. For it is easy to see that a similar throat-swelling in the ancestors of this bird may have given place to a pocket-like structure which in course of time increased to form what, for the sake of the simile, we may call the stocking-shaped bag of to-day. The gradual increase of the pocket to its present proportions is to be attributed to the fact

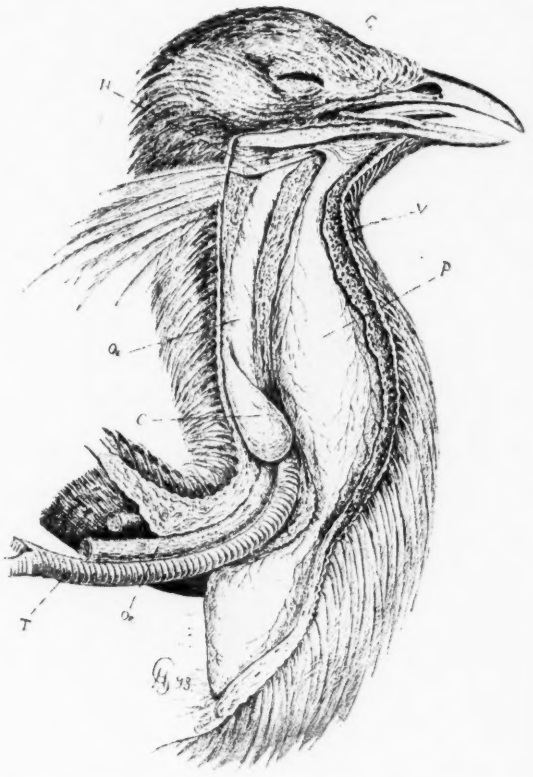

FIG. 2.—Dissection of the right side of the neck of the Great Bustard, *Otis tarda*, to show the hour-glass-shaped gular pouch. Drawn from the specimen in the British Museum. *C*, Crop; *H*, Hyoid; *Oe*, Oesophagus; *P*, Pouch; *T*, Trachea; *V*, Vascular tissue, investing the upper part of the pouch.

that the birds with the largest throat pouch found most favour with the females of the community and were selected on this account as mates. The birds with the largest throat pouches being selected in each succeeding generation, the present race, with its enormous wind-bag, was produced.

The only other bird with a throat pouch filled in the same way as that of the great bustard is the Australian musk-duck (*Biziura lobata*). The males only bear the pouch, which differs conspicuously from that of the bustard in that it is external, hanging down, purse like, from the lower jaw. Nothing, however, appears to be known as to the use to which the pouch is put, but there can be little doubt but that it is a purely sexual character, and displayed as a charm during courtship.

Many lizards possess throat pouches of this kind, but whether they are in all cases used exclusively for the purposes of display we do not know; on this point observation by travellers is silent. In many cases the inflation of the pouch is accompanied by a display of brilliant colour over its surface. For example, in one of the iguanas, *Anolis carolinensis*, of the south-eastern United States, the pouch, when placid, is white with a few lines and spots of red, but at the moment of inflation it becomes suffused with a brilliant vermilion.

The curious but unsightly air-sac of the adjutant stork may well close this series of examples of ornamental wind-bags. Doubtless many of our readers have watched, in the London Zoological Gardens, the ease and rapidity with which this sac can be filled and emptied. Like that of the great bustard it is a specially developed structure, and quite distinct from the gullet. Unlike the pouch of the bustard, however, its general form and proportions, both when inflated and when empty, are visible externally, for it is quite pendulous, and covered only by the bare skin of the neck. Moreover it is present at all seasons. Empty, it looks like a small conical bag projecting from the front of the neck, but when filled, its shape is completely changed since it forms a bladder-like body a foot and a half long. The method of inflation is quite unique, the pouch communicating with a large cavity below the orbit on the left side of the base of the skull, and this opens directly into the nasal cavity.

WHORLS AND CRESTS OF HAIR AS ANIMAL PEDOMETERS.

By WALTER KIDD, M.D., F.Z.S.

THE works of man which he devises for his physical and mental advancement are marked by a precision varying with the degree of maturity of his science, and one of the smaller among these is the pedometer, an instrument requiring here no description. By a somewhat elastic use of the idea of a pedometer, one may find among the phenomena of nature certain which may be termed *animal pedometers;* these, like all the products of nature's handiwork, are lacking in the exactness of human appliances. But they are none the less significant of certain habits belonging to the animals which possess them.

Comparatively few animals can be said to carry about on their bodies a register of their locomotive activity as a cyclist does on his machine, or a pedestrian in his pocket. Nevertheless, those few mammals that display pedometers on their hairy coats, "*urbe et orbi*," show an advance in one particular upon any of man's pedometers, inasmuch as fairly clear records of ancestral as well as individual activities are indicated. The phenomena here looked upon as animal pedometers are those arrangements of hair which we know as whorls, found in various regions of the bodies of animals, and seldom in any but the short-coated forms. These whorls do not often exist alone, but usually are associated with a feathered arrangement which proceeds against the general stream of hair adjoining them, and this feathering generally terminates somewhat sharply in a ridge or crest. Whorls, featherings, and crests then constitute a fully-formed "pedometer" in this connection. The best examples of these, and the most familiar, are those seen on the horse, and they are so far removed from being accidental or indifferent phenomena, and are so clearly brought under certain simple laws of physical causation, as not only to deserve but to demand interpretation. Few thoughtful persons will dissent from the remark in the conclusion of Jevon's Principles of Science, where he says, "Now among the most unquestionable rules of scientific methods is that first law that *whatever phenomenon is, is.* We must ignore no existence whatever; we may variously interpret or explain its meaning and origin, but if a phenomenon does exist, it demands some

kind of explanation." To these small and apparently unimportant fragments of nature's handiwork, which are here called pedometers for the sake of emphasis, this unexceptionable remark of the great logician applies.

It may be best at the outset to state that, from their intrinsic importance, whorls, featherings and crests are excluded entirely from the province of any form of selection, being in no way useful to the animal possessing them, and in no degree produced by artificial selection or breeding. Their production must be sought elsewhere, and no view of this is forthcoming but that which considers them as by-products of muscular action in a long line of ancestors, and in a very striking way they register the degree and range of this action.

As already stated, the best examples of the phenomena in question, and the greatest number, are to be found on the coat of the domestic horse, and these will first be described. The best known is that graceful feathering which passes upwards in the hollow of the flank, dividing the trunk of the animal from the great rounded mass of muscle of the hind-quarters, and the feathering presents a direction slightly concave forward. It commences at the fold of skin, which passes from the lower part of the abdomen to the hind-limb, by a whorl or vortex of hair. This radiates and expands into a bilateral and symmetrical expansion shaped like the barbs of a feather. The latter proceeds upwards in the inguinal hollow as far as the level of the iliac crest, where a projection covered by muscles is always to be recognised, and here it abruptly terminates in a ridge or crest. The crest is very noticeable in all domestic horses, and lies parallel with the long axis of the trunk. Above it, and on either side of it, are seen the hair-streams from the back of the animal, breaking away like two currents of water on either side of an outstanding rock, the anterior stream passing with a wide curve forwards and downwards along the side of the abdomen, and the hinder one more directly in its original course along the great swelling mass of the hind-quarters. A better idea of the actual arrangements of the hair-streams will be gathered from an inspection of the coat of any common horse, whose coat is not too long, than can be conveyed by a written description. The symmetry and constancy of this arrangement is very striking and demands explanation. This is more fully treated in (1), (2), (3),* and it may be shortly stated that these breaks in the uniform direction of the hairy covering of the horse, and other animals, as well as in other regions of their bodies than the inguinal, are due to the constant traction, during exercise, of underlying and diverging muscles. It is here maintained that they fairly bear the name of pedometers because of the close way in which the degree of locomotive activity is registered according to the persistence, size, and constancy of these otherwise uncalled-for arrangements of hair. When a few horses in the act of trotting are watched, and the accompanying diagram of the main muscles of the horse and the commonest whorls, featherings and crests are borne in mind, it is seen at once that the very conditions required to produce some departure from the ordinary slope of the hairs in the inguinal hollow are present, if indeed it be a possibility that underlying divergent muscular traction should influence the course of the living growing stream of hair on that portion of the skin which lies over the area affected. If also a few horses be watched as to the degree and extent of the "jolt" which occurs at every quick step, and the sharp limitation of this to the area included in that of the whorl, feathering and crest—ceasing, as it does, abruptly and significantly at the level of the crest of the ileum—the *modus operandi* is very clear. The forward range of the

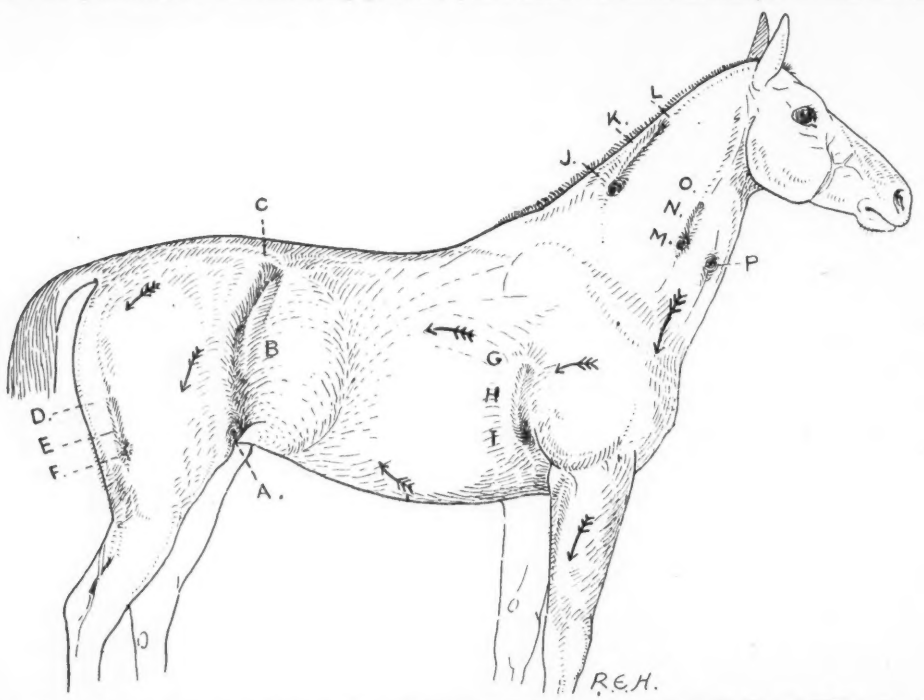

FIG. 1.—Side View of Horse: A, B, C, Inquinal Whorl, Feathering, and Crest; D, E, F, Gluteal Whorl, Feathering, and Crest (very rare); I, H, G, Axillary or Post-humeral Whorl, Feathering, and Crest; J, K, L, Upper Cervical Whorl, Feathering, and Crest; M, N, O, Middle Cervical Whorl, Feathering, and Crest; P, Lower Cervical Whorl.

* (1) *Proc. Zool. Soc. Lond.*, 1900, p. 682. (2) "Use-inheritance": A. & C. Black, London, 1901. (3) *Proc. Zool. Soc. Lond.*, 1902, p. 156.

"jolt" is much wider than the backward, and marks out most closely the degree of the forward curve taken by the anterior hair-stream, which descends from the crest. In passing, one may note here a very small and unimportant point, but one which is of some interest. During or after a short shower of rain the flank of a horse presents a

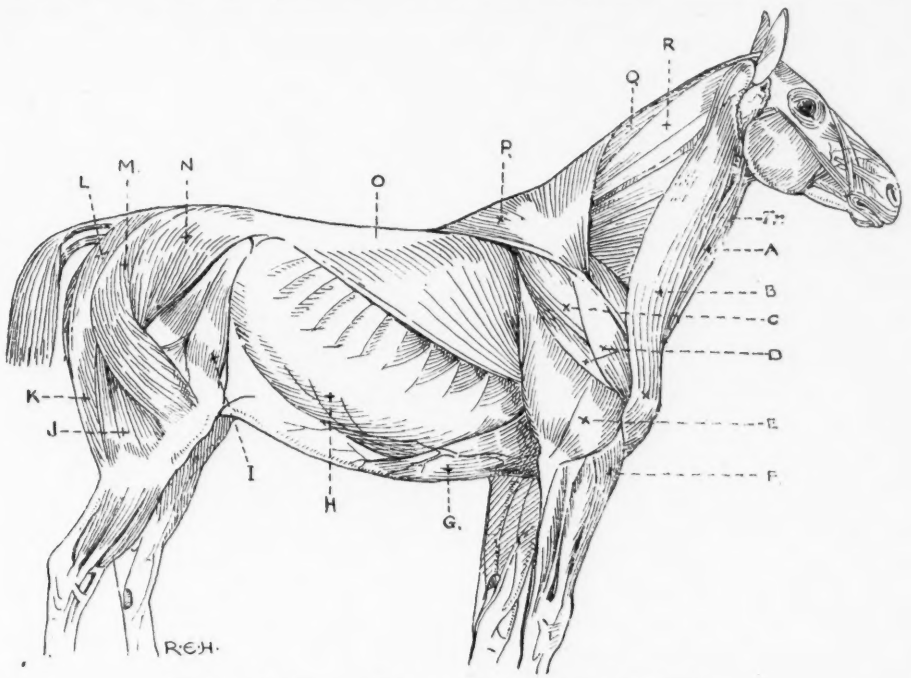

FIG. 2.—Side View of Horse showing chief Superficial Muscles.

curious distribution of the moisture. At a point just where the proper forward stream from the feathering joins the main stream of hair from the thorax and abdomen, a definite line of darker moist hair is seen, and the moist surface is confined closely to the anterior part of the trunk, and separated from that of the hollow of the flank. This line of demarcation very clearly indicates the position where the forward "jolt" in rapid action terminates.

For the production of these and kindred peculiarities in other animals no other than this dynamical explanation is forthcoming, and no other seems to be required. The arrangements of hair described is the best, because the most familiar, of the pedometers displayed by animals on their bodies.

Attention to the facts of the horse's life and certain related or contrasted facts of the lives of other animals will show the reasons for which such hair-arrangements are looked upon as registers of long-past and present activities of the species in question. The domestic horse is the most locomotive of animals, wild or domesticated. It has been produced by man out of a wild plastic stock, with some such ancestors as the wild (Prejevalsky's) horses now at the Zoological Society's Gardens, and by a process of selection during many generations, first in its Central Asian cradle, and later all over the civilised world. It has been as much made by man for his purposes of locomotion, draught and traffic, as a locomotive engine has been made by him. The one has been made by the laws of applied physics, and the other by those of biology. Thus the domestic horse is in the unique position of being the locomotive animal *par excellence*, and that not for its own needs, but for those of higher creatures who have availed themselves of its potentialities provided by nature. These considerations show the domestic horse to be the best specimen which can be found for the study of animal pedometers, and by comparison of this species with all other known hairy mammals it is found to be as much better furnished with pedometers of the kind indicated as it is greatly in advance of them as to the frequency and rate of its locomotive activity.

There are two closely related animals, the domestic ass and mule, which ought to show this inguinal pedometer, if mere heredity or some variation incidental to the group of animals could be fairly invoked to account for it. These also are locomotive animals, but in a degree very much less than the horse, and their pace is of a quieter and less free character. What then do we find in them as to the size and persistence of the inguinal pedometer? In the ass it is absent (the writer has met with one exception), and in the mule it is variable and occupies less than half the area of that in the horse. These facts agree very closely with the hybrid character of the mule and with the differing locomotive activities of horse, mule and ass. Prejevalsky's horses show a whorl and feathering of an oval shape and limited size, very much like that of the mule. The onager (*Equus onager*), closely resembling these three domestic animals in form, shows an inguinal whorl or pedometer large and well defined, though much less so than in the case of the horse, which is in keeping with its character for remarkable fleetness and activity. Zebras of the three forms, Mountain, Grevy's and Burchell's zebras, show no whorl here at all, in spite of their close resemblance in size and form and *power* of locomotion to the horse. Their wild lives, lived only for their own sake and not for that of man, have been only locomotive in the intermittent way which is incidental to all wild life.

The domestic ox, and most of the Bovidæ, show no

inguinal whorl, and in the case of the former we can explain, from our knowledge of its slowly-moving action and general heaviness, this negative fact.

Among the Bovidæ certain antelopes, gazelles, and sheep exhibit a more or less defined inguinal pedometer, and these are given in more detail elsewhere.*

The special instance of an animal pedometer, which has been described at some length, will serve to illustrate others less well known, and among these, as one would expect, the greater numbers are found in the domestic horse.

Behind the large mass of the muscles of the shoulder, and in a hollow corresponding to the inguinal hollow, there is found just below the withers of some horses a whorl which may be counted among the pedometers of that useful creature. Being not a constant phenomenon it is the more significant from one point of view, for it is evidently a pedometer in process of evolution at the present time. It is never so highly developed or so large as the

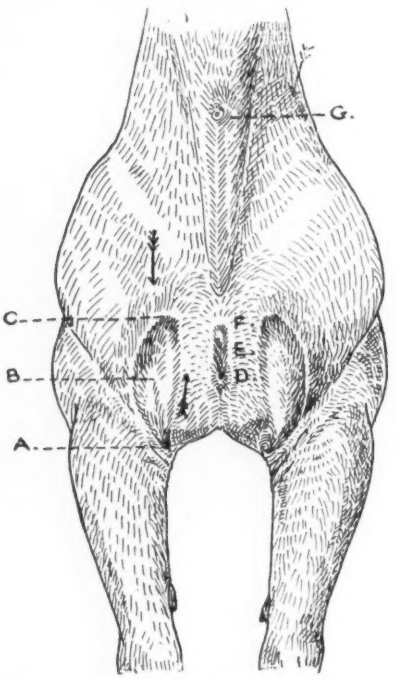

FIG. 3.—Front View of Horse's Chest, showing the Whorls, Featherings, and Crests.

inguinal, and out of 2159 horses examined it was found to exist in only 42 cases, or about 2 per cent. In another group of 87 cases in which it existed there were 57 cart-horses, and this singular fact is readily accounted for when one recollects that this hollow is a region where a decidedly less extended range of action occurs than is the case in the inguinal, except in the particular instance of the cart-horse, where it is markedly greater than in any other form. It is sufficient to watch a fine English cart-horse drawing a heavy weight, and to compare with this action even that of the high-stepping hackney, to see at once why the preponderating muscular activity of the cart-horse in this area is stamped upon its hairy covering as a whorl, or pedometer. Here again is the degree of locomotive activity registered by the frequency and size of a whorl

* *Proc. Zool. Soc. Lond.*, 1900, p. 686.

and its associated phenomena. This particular post-humeral pedometer is also found in other Ungulates, and the most noticeable specimens are found in the same group of animals as the inguinal whorl, and these are given in detail in the same place.*

On the pectoral region of certain animals, among which the Ungulates in general and the horse in particular may be mentioned, there is a bilateral symmetrical whorl with feathering and crest, as a rule, associated. Here, again, is a pedometer which registers the general activity of the species and its ancestors, and the individual range and frequency of movement of the great muscles which flex the "elbow" of the animal. In our familiar show-specimen, the horse, it is invariably present and fully developed, varying only to a slight degree in size in differently developed individuals of this convenient species.

In many wild animals it is present, as in many Bovidæ and a few of the larger Carnivores, but never with the uniformity and degree of development that occurs in the

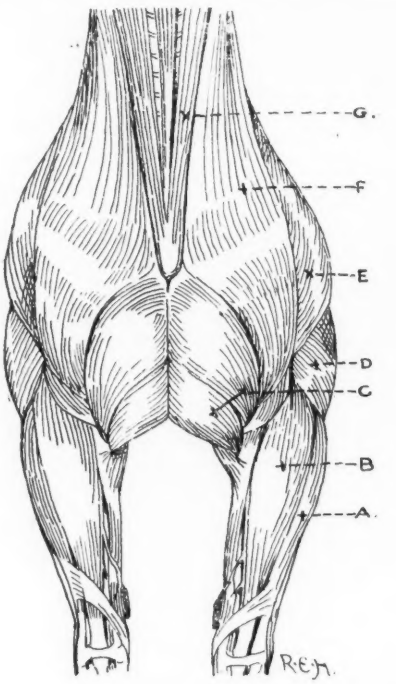

FIG. 4.—Front View of Superficial Muscles of Horse's Chest.

horse. Once more the ass and mule deserve special notice as to the degree in which the pectoral pedometer is displayed by them. In the mule it is small, narrow, nearly always present, in the ass it is very rarely present; indeed, as mentioned above, the present writer has only examined one specimen in which it occurred. The horse has been stated to show the pectoral pedometer invariably, but the importance of this fact does not end with its constancy, for many degrees of its width and length are to be observed, and it is a rule to which no exceptions have been so far found, that the general development of it is in a direct ratio with the action of the horse in question. In cart-horses, powerful carriage horses, and funeral horses it is highly developed, and in shambling ill-bred hackneys, such as one sees in the streets of Italian cities, it is very

* *Proc. Zool. Soc. Lond.*, 1902, p. 686.

narrow and ill-developed. Some of these poor specimens, if examined as they approach, as to their pectoral pedometer alone, would be taken for mules, which resemble them most closely in this particular, and indeed in general build as well. It is not necessary to do more than point out the close correspondence of the relative locomotive activities of the horse, ass, and mule with the degree of development of the pectoral, as was seen in the case of the inguinal pedometer.

In point of importance, from the present aspect of them, the pedometers in the inguinal, pectoral, and post-humeral regions may be numbered 1, 2, 3.

There are several other situations of the animal body where whorls, featherings, and crests occur, but these three that have been mentioned are the only ones that can be described as pedometers, the others being either due to pressure or being secondary to general muscular activity, as in the sides of the neck, but not being by-products of *locomotive* activity *per se*. The horse, again, is pre-eminent in these other whorls, inasmuch as it presents no fewer than three invariably, and nine frequently.

A few facts concerning these particular whorls, featherings, and crests may be alluded to in conclusion :—

1.—They occur in a direct ratio with general muscular development in an animal, and the difference between the size and definition of the whorl of an animal which is large and fat, but not muscular in proportion, and an animal which shows good muscular development, is very significant.

2.—They never occur over the middle of one large muscle, and only where groups of muscles underlying the part exercise traction in opposing directions.

3.—They never occur in Carnivores ; though here it may be said *exceptio probat regulam*, for two out of the vast number of Carnivores examined, viz., two long-bodied domestic dogs of the dachshund type, with very strong fore-quarters, showed a rudimentary post-humeral whorl.

It may prevent misconception to state here that the term "pedometer" is used loosely, and chiefly by way of illustration, but that it is faithful to the facts, which are of a simple order, and open to the study of all whom they may concern.

THE SUN'S DUSKY VEIL.

By Miss AGNES M. CLERKE.

NONE of the solar appurtenances is more obvious to inspection than the screen of attenuated matter overspreading the photosphere. Already, in 1612, Lucas Valerius recognised the darkening of the sun's limb which results from its action. Bouguer, more than a century later, measured the gradations of darkening; Laplace calculated, from the basis of Bouguer's measures, the total amount of light-stoppage in the so-called atmosphere ; and Father Secchi perceived the stoppage to be selective, the surviving marginal rays showing a rufous hue. Moreover, since these are very imperfectly actinic, photographs of the sun exhibit the edges of the disc as much more obscure than they appear to the eye. The solar and terrestrial atmospheres are then so far alike that both are heavily absorptive of blue light, while transmitting red and yellow beams with comparative freedom. Yet it does not follow that the sun resembles the earth in being surrounded by an envelope of refrigerated gases. This is indeed impossible under the given conditions. Let us briefly recall their nature.

The sun's tinted screen must be situated in the immediate neighbourhood of the photosphere.* Faculæ visibly overtop it ; their upper sections escape the dimming effects of its intervention. They seem like half-submerged stakes in a tideway, that serve, not only to mark the channel, but to show the depth of the water. Now faculæ themselves can be readily located. They are clearly photospheric protuberances. This relationship attests itself indeed to the eye, yet still more convincingly by spectroscopic evidence. Facular light is impressed with the whole array of Fraunhofer lines. It escapes none of the absorption exercised by the vaporous layers near the sun. It has then demonstrably been sifted through them. Faculæ, then, rise from the photosphere, surmount the screening envelope, and are immersed in the reversing stratum. A vaporous layer, however, lying between the reversing stratum and the photosphere, should necessarily be incandescent ; and incandescent gases stop only special luminous vibrations; they are incapable of producing a general absorption, such as shadows the solar limb. Hence the interposing veil can only be of a pulverulent composition ; cool vapours, placed in the torrid situation where it exists, should, in a few minutes, become glowing ; and the action of glowing vapours would be indistinguishable from that of the reversing layers.

But whatever its constitution, there can be no doubt as to the importance of its function in the solar economy. Stripped of its "atmosphere," the sun would appear fully one stellar magnitude brighter than it actually does. The change might be described as equivalent to the rise of Aldebaran to the rank of Arcturus. Further, its thermal power would be nearly doubled.† As one result of the subsisting arrangement, then, the solar expenditure of energy is strongly controlled. The resources of the great globe are husbanded, and its vital span must be proportionately lengthened. Hence the solar stage of development may be inferred, on this ground alone, to be one of relative permanence. For white stars, radiating from bare photospheres, waste their stock of power recklessly ; while the provision of a "niggard" apparatus in later life prolongs existence by economising the means of sustenance.

Dr. J. Halm is perhaps the first investigator adequately to appreciate the significance of that darkening of the sun's limb which is so easy to observe, so difficult to account for. "One would have thought," he writes‡, "that such an important fact as this quite enormous light-and-heat-absorbing faculty of the solar atmosphere would have led solar physicists to enquire whether, in view of the stupendous changes going on incessantly at the sun's surface, we can possibly rely on the absolute constancy of the solar envelope, or whether the density of the absorbing matter might not rather be exposed to variations which would lead to serious consequences as regards the maintenance of the thermal equilibrium in the solar body. So far as we know, however, such an attempt has never been made."

But the author has evidently overlooked the enquiry started in 1890 by Mr. Wilson, of Daramona, and Dr. Rambaut, the present Radcliffe observer, as to the real occurrence of just the variations in question.§ They laid down the plan of observations designed to extend

* Dr. Scheiner, it is true, places it in the chromosphere ("Strahlung and Temperatur der Sonne," p. 50), but gives no satisfactory reason for the transference.

† Professor Frost found, from an elaborate series of experiments, that the sun's output of heat would be augmented 1·7 times by the removal of its absorbing envelope (*Astronomy and Astrophysics*, Vol. XI., p. 731).

‡ *Annals of the Royal Observatory, Edinburgh*, Vol. I., p. 74.

§ *Proc. Royal Irish Academy*, May 9th, 1892.

throughout an entire solar cycle, but only some preliminary sets were executed, and the project was left in abeyance. The subject has been quite lately—since the appearance of Dr. Halm's discussion—resumed by Prof. Very in America.* By means of spectro-bolometric measures at various points on the sun's disc, he proposes to ascertain whether the curve of diminishing radiant energy from centre to limb remains constant, or alters in form from time to time or progressively; and this, as Mr. Wilson and Dr. Rambaut had pointed out, would serve to test the occurrence of changes in the quality or depth of the solar atmosphere. The quantities concerned would in any case, Prof. Very remarks, be of a very small order; still, he regards their discrimination as possible by an extension of the method practically exemplified in his paper, the determinations being made predominantly at epochs of spot-maxima and minima. Only at a great public observatory, he adds, could the grasp and continuity needed to give substantial value to the work be secured.

Meanwhile no proof—no suspicion even of a proof—is as yet at hand of fluctuations in the effectiveness of solar heat-conservation. That it has a secular tendency to augment is, however, rendered probable by the fact that stars, on the whole, redden with antiquity, and upon this slow process interruptions may possibly supervene. The question remains open. The affirmative answer to it supplied by Dr. Halm is based upon theoretical considerations. He assumes that the sun is a cooling body, and hence that the absorption due to its waste products is, on the whole, in course of intensification. Nevertheless, vicissitudes have to be reckoned with, and their consequences are supposed to occasion and prescribe all the complex phenomena connected with the periodicity of the sun. For intensifying absorption brings in its train an excess of heat-retention. The protective envelope becomes over-protective. It more than redresses the balance between thermal loss and gravitational restoration. Superheating sets in, eruptions ensue, and the atmosphere is temporarily cleared. Then the swing of change begins anew. The eleven-year cycle is in fact established.

There is much in this speculation that allures thought. It is novel, it is reasonable, it smoothes away some outstanding difficulties, it affords a prospect of escape from the weary round of abortive hypotheses. It seems, above all, comprehensive enough to include the problem of light-variability in red stars. Yet, when we come to details, the way out appears, after all, to be hopelessly blocked. Like many other solar theories, this new and highly ingenious one promises more than it can perform. Its merits are undeniable; but it does not meet the full exigencies of the situation.

The cyclonic hypothesis of spot-formation does duty once more in Dr. Halm's solar scheme. Eruptions take the initiative; their subsiding materials diffuse into polar and equatorial currents; and the encounters of those oppositely directed, and issuing naturally from different sources of disturbance, produce vortices showing to the eye as spots. But these are affected by no such conspicuous and systematic internal movements as should appear in them if they in truth originated after the supposed fashion. Spots fitfully gyrating do indeed occur, but they attract attention as rarities. No more than two or three per cent. of the whole thus distinguish themselves. And even in these the movements are capricious and unmethodical. Opposite rotations are sometimes perceived to proceed simultaneously in different members of a single spot-group; nay, one of the aggregated umbræ may wheel by turns in contrary directions. Effects so casual cannot depend upon a fundamental cause; and they indeed necessarily arise when matter drawn towards a centre deviates, however slightly, from a radial course. Dr. Halm tries to reconcile the contradiction between what his theory demands and what observation attests by suggesting that the gyrating portions of a spot are mainly those that are invisible; but the plea is inadmissible. A genuinely spiral structure should throughout bear the imprint of certain characteristic features. The "thatched edges," for instance, which so often constitute penumbræ, could no more subsist as the garniture of a whirling umbra than the ship of Ulysses could have escaped engulfment by Charybdis. Nor are the umbral cavities uniformly dark. Secchi frequently saw them overspread with a sort of floccular haze; Mr. Maw has noted in them delicate, vein-like traceries; and the "black holes" first detected by Dawes are unmistakably chasms of irregular shapes and stationary behaviour, not foci of swirling movements. The claims to acceptance of the cyclonic theory of sunspots are in fact less plausible now than they seemed thirty years ago, when less evidence had been accumulated by which to try their validity.

This, fatal though it be, is not the only objection to Dr. Halm's views. They are also in glaring disaccord with observation as regards the connection of spots with prominences. They involve the production of spots, certainly as a consequence, but far from the neighbourhood of a primary outburst of metallic flames; while for the avowed object of harmonising this state of things with what is actually seen, a further expedient is resorted to.

If a spot be a vortex, there must be an indraught of the surrounding atmosphere towards its centre. The screening action accordingly, owing to which heat collects and finally occasions eruptions, should be particularly effective over a maculated region. Hence, it is alleged, the close association of prominences with spots. But what are the facts? Far from being obscured by extra-absorption, spot-bearing tracts of the photosphere are usually of dazzling brilliancy. And for this precise reason that they are often measurably *humped up* as if by the relief of pressure, thus partially discarding the veil uniformly spread over the unbroken disc. The escape of heat pent up by an atmospheric cloak has then assuredly nothing to do with the genesis of prominences.

There are indeed many more reasons than can be here adverted to in detail for rejecting the opinion that spots are mere eddies in the drifting luminous material of the photosphere. Thus Mr. Maunder has expressly dwelt, in the pages of this journal, upon peculiarities in their movements and mode of development indicating their deep-seated nature.* And the strange frequency of antipodal outbreaks, both photospheric and chromospheric, intimate as their precedent conditions, disturbances reaching to the very core of the globe.

Dr. Halm's interpretation of solar phenomena cannot, it is clear, be accepted in its entirety; yet it includes much that is instructive and suggestive. Especially noteworthy is the relation elicited by him from Spoerer's and Carrington's observations, between the rate of solar rotation and the condition of the solar surface. When spots are numerous, he finds reason to conclude that the equatorial drift is quicker by 750 miles a day than when spots are scarce. The figures tabulated certainly show a cyclical variation of the indicated kind; and the result is in itself plausible. It needs, however, to be verified, since figures are apt to show illusory coincidences which vanish with the repetition of the series. But the enigma of the sun's rotation has hitherto proved so baffling that any hint towards its solution is welcome; and should

* *Astrophysical Journal*, Vol. XVI., p. 73.

* KNOWLEDGE, Vol. XVII., p. 200.

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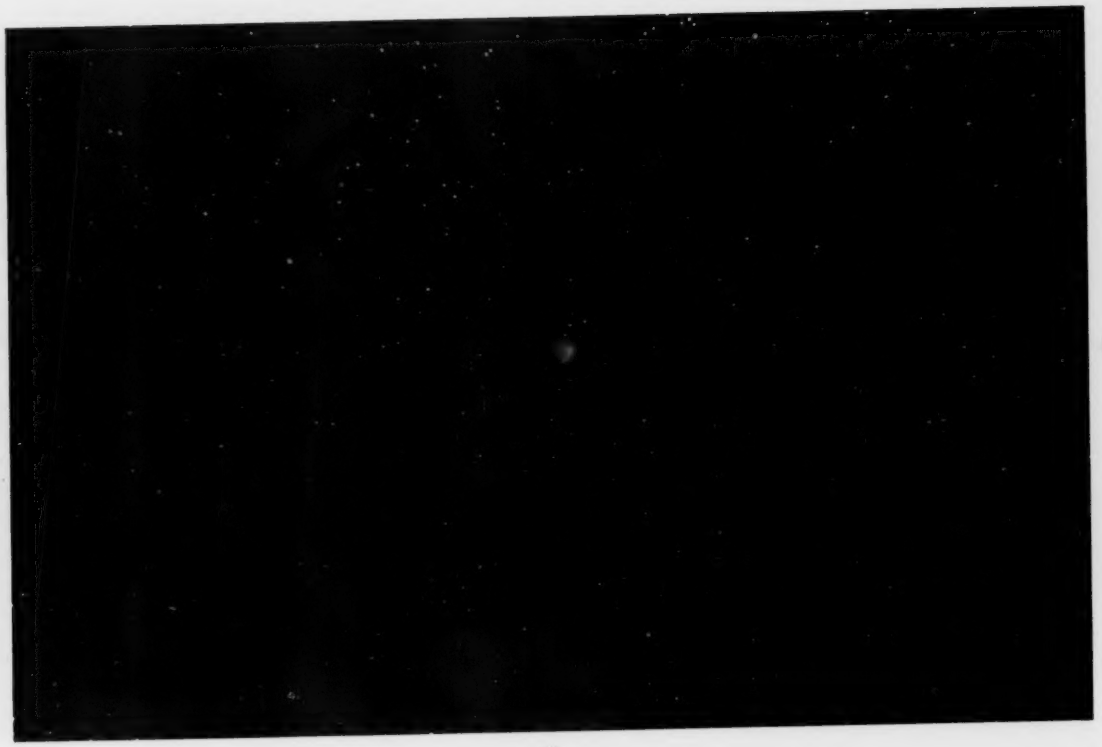

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COMET *b* 1902 (Fig. 1).

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COMET *b* 1902 (Fig. 2).

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its angular speed be proved actually to fluctuate synchronously with the eleven-year wave of solar commotion, an important step will have been made towards unravelling its intricacies.

The whole subject of solar physics is, year by year, taking a wider scope, and acquiring a deeper significance. The complexities of the lighting and warming apparatus of our system, its self-regulating power, the manifold interplay of its parts, the fine poise of its equilibrium, strike us with increasing wonder as we become more intimately acquainted with them. More and more keenly, too, we feel our ignorance as we advance in knowledge; information on many points is, indeed, still in a visibly rudimentary state, but it is gradually gaining further items, and while ambitious theories are constructed only to collapse, something of value survives from the wreck of each—a crucial circumstance previously overlooked, an original train of reasoning, a valid analogy. The gate of mystery, it is true, remains closed, notwithstanding the many "Open Sesames" that have been uttered in front of it. Yet it hangs more loosely on its hinges than of old, and science has fresh engines in reserve.

PHOTOGRAPHS OF COMET *b* 1902 (PERRINE).

By ISAAC ROBERTS, D.SC., F.R.S.

SIX photographs of the comet have been taken at my observatory with the 20-inch reflector, and five with the 5-inch Cooke lens simultaneously, between September 6th and October 10th, 1902, and the two photographs on the plate annexed illustrate the appearance and show the position of the comet on the days herein given.

Fig. 1.—The comet is shown as it appeared on the 6th September, with an exposure of the plate during ninety minutes; the plate being held, by aid of the clock mechanism, steadily on one point in the sky whilst the comet moved in its course, leaving a trail on the film which represents the distance it travelled in its orbit during the exposure of 90 minutes. On examination of the trail on the negative, by aid of a lens, it is seen to be formed of a series of circular dots which closely resemble the images of rather faint stars that are visible on the plate around the comet; but inasmuch as the comet was travelling in its orbit at the rate of about 1·15 seconds of arc each minute of time during the 90 minutes' exposure of the plate, and only eight dots are visible in the trail, it follows that a very short interval of time was required to form each dot.

How were the dots formed? There was no movement of the plate during the exposure that would account for them, and the comet, we must assume, kept steadily on its course along its orbit without jerking or stopping. The answer to the question is, doubtless, that during the exposure of the plate the transparency of the atmosphere varied frequently, and the clear intervals, though of very short duration, sufficed to give the highly actinic nucleus time to leave its image on the film, but when less clear intervals occurred, the nuclear image varied in intensity down to invisibility. These facts indicate that the nucleus was of globular form; that it was highly actinic, for although surrounded by a dense *coma* of nebulous matter, it did not obstruct the light of the nucleus so as to prevent its image being formed on the film in a few minutes of time. The nuclear images are round notwithstanding the rapid movement of the comet in its orbit. The diameter of the nucleus measured about 14 seconds of arc, and the length of the trail about 103 seconds.

Fig. 2.—The photograph was taken on the 10th October, with an exposure of the plate during 52 minutes in the 20-inch reflector, and it will be observed that the star images upon it consist of a series of zigzag trails, whilst the nucleus of the comet is round. In this case the nucleus was used as a fixed point for guiding purposes, whilst the images of the stars are trails which represent the distance in space over which the comet moved during the exposure of 52 minutes. The trails were produced by the frequent necessity of moving the photographic plate, in order to counteract the motion of the comet, and keep it, as steadily as possible, upon the crosswires in the eye-piece of the guiding telescope during the whole exposure; the number of the zigzags in the trails register the number of the corrections made during the exposure of 52 minutes.

The comet appears, on this photograph, as if it had been viewed at rest in a telescope, and the various details in its structure are therefore seen with but little distortion.

I do not consider it necessary for me to write any descriptive matter here; each reader can see for himself, by examination of the photographs, the *coma*, the tail divided with rifts, and the separation into two tails. One of them is about two degrees in length, and the other about one degree. Of course some of the fainter details can only be well seen on the original negatives, six of which are available for examination in the event of any scientific investigations requiring their use.

THE LUNAR ECLIPSE OF 1902, OCTOBER 16.*

A series of measures was made by Prof. W. H. Pickering of the diameter of the bright spot surrounding Linné before and after the passage of the shadow of the earth during the total lunar eclipse of October 16, 1902. The measures were all made in a north and south direction, with the filar micrometer attached to the 15-inch equatorial. The magnifying power used was 550 diameters. The seeing was fairly good, and nearly uniform throughout the observations, being about 5 on the standard scale of 10 (*Harvard Annals, XXXII.*, 120). After the passage of the shadow, it was slightly inferior, perhaps 4. Unfortunately clouds stopped observations before an absolute measure of the quality of the seeing could be made. Various corrections were made to the measures for the thickness of the micrometer thread, the pitch of the micrometer screw, and for a subjective effect described in *Harvard Annals, XXXII.*, page 204. During the observations on October 16 the sun had been shining on Linné from 8·5 to 8·7 days.

On October 16, on the approach of the umbra, and when the penumbra already lay across Linné, the white spot began to grow in size, and by the time that the umbra had passed away, its diameter was very materially increased by an amount of 2″·75. This increase was notably larger than that caused by the eclipse of 1898, when Mr. A. E. Douglas estimated by three different methods the increase to be 0″·82, 0″·73, and 0″·15; or than that of 1899, when Mr. W. H. Pickering estimated the increase to be 0″·14. Mr. Pickering remarks that in the present instance the great increase in size could not have been due to defective seeing after totality, for the effect of bad seeing on spots of this size is rather to diminish their dimensions, as shown by the measurements of artificial disks, and therefore could not produce the effect observed. "Moreover," he says, "this change in size was so conspicuous to the eye, even before I made any measures, that at first I queried whether the object could really be Linné. To satisfy myself I re-identified it by means of some small craterlets in its immediate vicinity. It is certain that at no time during the observations was the

* Harvard College Observatory Circular, No. 67.

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seeing as good nor as bad as it had been during some of the observations made in 1898 and 1899, when the spot was very much smaller.

"The real explanation of the unusually large change in the size of the spot," he continues, "I believe to be that Linné was more active than heretofore, and therefore that there was more moisture about it to condense.

"A series of measures made on October 20, at 15h. 26m., or $12^d{\cdot}6$ after sunrise, gave a diameter of $4''{\cdot}61$; seeing 3 in the standard scale. The seeing, as judged by the image of the moon, was clearly inferior to that at any time during the night of October 16. The image of Linné was much larger than it appeared by any of the measures made before the eclipse, and much smaller than it appeared by any of the measures made after it. It therefore appears that the sudden increase of size after totality could not be due to inferior seeing.

"It also appears that on or before October 20 the spot had again begun to shrink in size, due, presumably, to evaporation in the intense sunlight. Four measures of the spot made in 1898, from $12^d{\cdot}4$ to $13^d{\cdot}7$ after sunrise, gave diameters of $3''{\cdot}52$, $3''{\cdot}24$, $3''{\cdot}42$, and $3''{\cdot}46$ (*Harvard Annals, XXXII.*, 206). The measures made on October 20, 1902, $4''{\cdot}61$, therefore confirms those of October 15 and 16, in showing that the spot has increased in size during the last three years."

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the December issue of KNOWLEDGE is a letter on the visibility of the crescent of Venus with the unaided eye, with regard to which I should like to make a remark.

At the time of the observation—the end of October or beginning of November, 1901—Mercury would, of course, be a beautiful crescent.

The writer of the letter points out the planet to two naked-eye observers, and then they are shown the crescent in the telescope. Their attention is *then* directed to a similar object in proximity to that just examined. Now, under the circumstances, perhaps it is not altogether surprising that one of them should have the sagacity (shall I call it) to infer that the "shape" would be "just like the new moon."

But the second part of the observation, referring to the "rest of the star, the dark round we see," is beyond my comprehension, and I should like to ask the writer if he can kindly describe its appearance in the telescope. I suppose it had some reference to earthshine upon our satellite.

T. H. ASTBURY.

Croft Villas, Wallingford.

HABITS OF SANITATION.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have read with much interest the article by Mr. Cox on the "Domestic Economy of the Thrush." As regards the sanitary habits of the thrush and other birds, may I suggest that the practice is much more common than appears to be known, and was probably originally followed by all animals whose young are helpless and incapable of locomotion. The domestic cat disposes of the excreta of her young in the same way, and for the first three weeks her nest is absolutely sweet and clean.

M. S. S.

NOTES.

ASTRONOMICAL.—Fizeau's experiment for the determination of the velocity of light has recently been repeated on an imposing scale by M. Perrotin, Director of the Nice Observatory. The mean result of 1109 observations gives the velocity in vacuo as 299,860 kilometres or 186,328 miles per second. Taking the value $8''{\cdot}805$ for the solar parallax, as derived from observations of Eros, the theoretical value of the constant of aberration is $20''{\cdot}465$, which, it is gratifying to find, is exactly that adopted by the International Conference of 1896.—A. F.

NEW COMET (1902 *d*).—A new comet was discovered on December 2, and, though extremely faint at present, it occupies a very favourable position for observation. Early in December it was estimated as about magnitude $11\frac{1}{2}$. On January 1, 1903, the comet will be placed about nine degrees west of the bright star Procyon, and a week later may be found some eight degrees west of β Canis Minoris. At this period the comet will be nearly three times as bright as it was on the night of its discovery. Its motion is slow towards the north-west, and directed to the stars in the western region of Gemini. The comet is well visible during nearly the whole night, and promises to remain in view for a considerable period, for according to the elements of the orbit computed by Ebell at Kiel (*Ast. Nach.*, 3834), the perihelion passage will not take place until April 19 next.—W. F. D.

BOTANICAL.—It is probable, judging from the enquiries occasionally made, that the interesting articles published on the Mexican jumping bean are not generally known. The beans (or seeds) are not infrequently met with, being distributed as curiosities remarkable in possessing the power of motion. The cause of this motion was not difficult to explain, for on cutting through the seeds, a single whitish worm was found in each. This was the larva of an insect to which the name of *Carpocapsa saltitans* was given many years ago, but it was not till 1891 that Dr. Rose, of the United States National Herbarium, was able to identify the plant which produced the seeds, though it was known that it belonged to the Spurge family (Euphorbiaceæ). From the observations made by Dr. Palmer while collecting plants in Mexico, and from the specimens which were received from him, it was concluded that the source of the jumping beans was a new species of *Sebastiania*, which Dr. Rose called *S. Palmeri*. This is a diœcious shrub or small tree, with the usual three-celled capsule of the order. Each cell contains a subglobose seed about two lines in diameter. The larva is supposed to be hatched from an egg deposited on the outside of the capsule, which it penetrates while still very young. It remains for a long period in the larva stage, during which it feeds on the substance within the integuments of the seed, nothing remaining but a thin light shell, which on being detached readily responds to the peculiar movements of the larva within. Usually the seeds are moved from side to side, but sometimes they are made to jump short distances. The jumping bean insect is closely related to the common apple worm (*Carpocapsa pomonella*). It is known to attack the seeds of a second species of *Sebastiania* (*S. Pringlei*), while an allied species

is found in the seeds of *S. bilocularis*. In referring to the jumping bean, the late Prof. Riley called attention to the extraordinary seed-like galls found in great numbers on the leaves of some North American oaks. The ground where they have fallen seems to be alive with motion, and the noise which this causes resembles the pattering of rain. The galls are produced by *Cynips saltatorius*, which, in the pupa state, is said to be capable of jumping twenty times its own length.—S. A. S.

ENTOMOLOGICAL.—A most important contribution on the "Bionomics of South African Insects," with regard to the value of natural selection as explaining cases of "warning coloration" and "mimicry," appears in the latest number of the *Transactions of the Entomological Society of London* (1902, pp. 287–584, Pls. IX.–XXIII.), being the conjoint work of Mr. G. A. K. Marshall and Prof. E. B. Poulton. Numerous experiments on the palatibility, or otherwise, of Acraeine and Danaine butterflies and other insects with "warning colours" are recorded. The general impression given by the records is that "warning colour" is frequently, though by no means always, of protective value. Mantids, for example, appear not to recognise these colours as indicating distastefulness, though they often refused Acraeine butterflies after trial, and when induced to eat them through hunger, suffered in health. Perhaps the most valuable support afforded by Mr. Marshall's observations to the theory of natural selection is his undoubted demonstration that butterflies are frequently pursued by birds and superficially injured by them, thus effectually disposing of the objection that butterflies have nothing to fear from birds. The observations on seasonal dimorphism in the genus *Precis* are of very special interest. It seems likely that the striking difference between the dry and wet season phases of these insects is due to the need for perfect protective resemblance in the former season, when insectivorous animals are short of food, and the struggle for survival among insects is very keen, and to the advantages of warning colours in the latter season when insect life is abundant.

During the last ten years M. Chas. Janet has published twenty-two valuable "Etudes sur les Fournin, les Guêpes, et les Abeilles." His latest contribution is a careful study of the structure of the hind-body in the common red ant ("Anatomie du Gaster de la *Myrmica rubra*." Paris: Carré and Naud, 1902). The musculature, the nerve-centres, the digestive system, and the reproductive organs are described in detail, and the functions of the various parts discussed.—G. H. C.

GEOGRAPHICAL.—Dr. Sven Hedin, who read a paper on his last journey in Central Asia, to the Royal Geographical Society on December 8th, seems to lack no quality necessary for a great explorer. His previous journeys, as well as his latest journey of nearly three years' duration, have proved him to be one of the finest travellers the world has seen. Not only is he possessed of remarkable endurance and great pluck and determination, but he has great powers of observation, and understands besides what is important to examine and record minutely, while his knowledge of languages is extraordinary. In the short time available in an evening, Dr. Hedin could describe but a portion of his long and arduous journey, but we believe that a popular account of his expedition will be published shortly, while the scientific results cannot of course be made known until the mass of material and the records obtained have been worked out, and this will be carried out by specialists under the auspices of the Swedish Government. A part, at all events, of these results will be published in the English language. The geographical portion of the scientific results will be provided by the traveller himself, and the material obtained will necessitate the complete revision of existing maps of Eastern Turkestan. The following is an outline of Dr. Hedin's journey:—Leaving Kashgar, in Eastern Turkestan, in September, 1899, Dr. Hedin proceeded eastwards up the Yarkand River, and eventually arrived in the region of Lob Nor. Here he found a ruined town, which he twice visited and partially excavated. Amongst other valuable material, Dr. Hedin found in these ruins a number of Chinese manuscripts which throw light upon the physical and political geography of the interior of Asia during the first centuries after Christ, and show what prodigious changes have taken place in that part of the world during the last fifteen hundred years. These finds and Dr. Hedin's careful investigations of the neighbouring Gobi Desert lead him to the conclusion that Lob Nor, or the Lake of Kara Koshun, is gradually creeping northwards, and will eventually reach the bed in which it certainly was in the year 265 A.D. After the completion of this work in the Gobi Desert and round Lob Nor, Dr. Hedin went into camp for a month and prepared a large caravan for a journey southwards into Tibet. We have not space for a description of Dr. Hedin's two most determined and plucky attempts to reach Lhasa. Each time he was confronted and surrounded by greatly superior forces of armed Tibetans, who had the strictest injunctions not to allow him to proceed. After trying every means in his power to gain entry into the holy city, he was at last forced to turn to the west, and, crossing the northern part of Tibet from east to west (in itself a remarkable journey), he arrived at length in Kashmir in December, 1901. Spending his Christmas at Leh, and the early part of January, 1902, with Lord Curzon, at Calcutta, he then returned to the north, and, picking up his caravan again, proceeded from Leh back to Kashgar, where he arrived on March 14th, 1902.

ZOOLOGICAL.—At the meeting of the Zoological Society, held on November 18th, was read an extract from a letter from Mr. D. Russell, Hon. Sec. to the Otago Acclimatization Society, giving an account of the successful naturalization of the red deer in New Zealand. Two stags and six hinds had been turned out in 1868, and their offspring now numbered between 4000 and 5000 individuals. The carcases of some of these deer weighed from 500 to 600 lbs.

The variation in the shape of the antlers of the Scandinavian elk formed the subject of a communication from Dr. Einar Lönnberg, of Upsala, read at the following meeting of the same body. In this it was shown that elk are not unfrequently met with in Scandinavia with antlers of the general type of those recently described as *Alces bedfordiæ*; these elk also differing somewhat in bodily shape and colour from the ordinary form. Since, however, they do not seem to be restricted to a particular locality, they cannot apparently be regarded as indicating a distinct race. A reindeer skull, with antlers, from Novaia Zembia, was also described at the same meeting, and regarded as belonging to a new race nearly allied to some of the American forms of the species.

Two important memoirs on the fauna of the northern part of the Western Hemisphere have recently appeared. Under the title of "Grönlands Pattedyr," Dr. H. Winge (*Meddelelser om Grönland*, Vol. XXI.) publishes an annotated list of the land and marine mammals of Greenland. In the course of his notes he mentions that the reindeer skulls and antlers recently described by Signor Camerano as *Rangifer spitzbergensis*, are really from Greenland. The second of the two memoirs, by Mr. E. A. Preble, forming No. 22 of the *North American Fauna*, is devoted to the mammals

and birds of the Hudson Bay district. Although comparatively few forms are described as new, the notes in this memoir are very important to naturalists, since, judged by modern standards, our knowledge of the Hudson Bay fauna was very imperfect.

ROYAL SOCIETY'S MEDALS.—The medals of the Royal Society have been awarded this year as follows:—

The *Copley Medal* to Lord Lister, in recognition of the value of his physiological and pathological researches in regard to their influence on the modern practice of surgery. The main result of those researches, namely, the definite proof that the suppuration of wounds, no less than putrefaction, was the work of living organisms, was not reached as a happy accident; it was the natural outcome of long-continued scientific observation and reasoning.

The *Rumford Medal*, which is awarded for "new inventions and contrivances by which the generation and preservation and management of heat and of light may be facilitated," was given to the Hon. Charles Algernon Parsons. By his invention and perfection of the steam turbine, he has not only provided a prime mover of exceptional efficiency working at a high speed without vibration, but has taken a step forward which marks an epoch in the history of the application of steam to industry, and which is, probably, the greatest since the time of Watt

The *Royal Medals* were conferred upon Prof. Horace Lamb, for his investigations in mathematical physics, and Prof. Edward Albert Schäfer, for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain.

The *Davy Medal* was given to Prof. Svante August Arrhenius, for his application of the theory of dissociation to the explanation of chemical change.

The *Darwin Medal* was awarded to Mr. Francis Galton, for his numerous contributions to the exact study of heredity and variation contained in "Hereditary Genius," "Natural Inheritance," and other writings. It may safely be declared that no one living has contributed more definitely to the progress of evolutionary study, whether by actual discovery or by the fruitful direction of thought, than Mr. Galton.

The *Buchanan Medal*, awarded every five years for distinguished services to hygienic science or practice, is given to Dr. Sydney A. Monckton Copeman, for his experimental investigations into the bacteriology and comparative pathology of vaccination.

The *Hughes Medal* has been conferred upon Prof. Joseph John Thomson, in recognition of his contributions to the advancement of electrical science, especially in connection with the phenomena of electric discharge through rarefied gases.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Swallows' Nesting Habits.—Mr. COX, in his interesting article on the "Domestic Economy of the Thrush" (KNOWLEDGE, December, 1902), says that the parent birds seem to feed the young ones indiscriminately. The following will show that this is not the case with all birds. One morning a pair of Swallows flew through the dressing-room window into my brother's bedroom at Frocester Court, Gloucestershire, perched on a picture, chattered, and, apparently, took stock of the place. This they repeated for several days, and, finally, made a nest in the bedroom about on a level with one's head. During incubation the chambermaid might come into the room, and do her ordinary work, but if she went near the nest the bird flew out of the window. *If a stranger or any other member of the household* entered the room she flew out at once. On the other hand, she allowed my brother to do anything, take her off the nest and put her back, handle the eggs, and so on. When the young were hatched he noticed that the cock fed, say, No. 1 and then No. 3, the hen feeding Nos. 2 and 4; so he tried to puzzle them by repeatedly shifting the young ones; but the birds always knew which had been fed last, and never made a mistake. In course of time they flew, but always returned at night till, early one morning, the whole family, instead of flying out for the day as usual, perched on the rail at the head of the bed and kept up an incessant twittering for an hour or more, and then flew off not to return that year. I may mention that my brother had placed a chain and padlock on the window to prevent anyone closing it. A pair tried to repeat the process next year, but for obvious reasons were not allowed to do so, and the window was kept closed till, I suppose, they had selected a nesting place elsewhere.—GEORGE J. CHAPMAN, Carlecotes, Dunford Bridge, Sheffield.

Migration of Blue-headed Wagtails (Motacilla flava) in Kent and Sussex.—Mr. N. F. Ticehurst has lately been keeping observation, with Mr. M. J. Nicoll, on the migration of Wagtails along the coast of Kent and Sussex. The conclusion reached is that the Blue-headed Wagtail, which has been considered hitherto as an irregular visitor on migration to Great Britain, is a regular visitor over this whole area. It arrives from the 20th of April to the 1st of May, and it is thought that some remain to breed. The return flight of these birds consists chiefly of young ones, which pass about the third week in August.

Water Pipit (Anthus spipoletta) in Sussex.—At the November meeting of the British Ornithologists' Club, Mr. Howard Saunders exhibited a female specimen of a Water Pipit obtained by Mr. M. J. Nicoll in Rye Harbour on October 29th. This bird seemed to be the seventh example of the species recorded for Sussex, while a specimen had been procured in Carnarvonshire and another in Lincolnshire. The Water Pipit is very much like the Scandinavian form of the Rock Pipit. It seldom visits us, although it breeds as near to us as in the Alps and the mountains of Germany and Central Europe, as well as in the Pyrenees and some of the mountain ranges in the Spanish Peninsula.

Glossy Ibis in Ireland (The Field, November 29th, 1902, p. 930.)—The Glossy Ibis has been recorded from England several times this autumn, and now Messrs. Williams, of Dublin, record that a male specimen was shot in Co. Clare and a female near Wexford.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

Notices of Books.

"HISTORY OF ASTRONOMY DURING THE NINETEENTH CENTURY." Fourth edition. By Miss Agnes Clerke. (A. & C. Black. 1902.) Illustrated. 15s.—In a few words Miss Clerke gives a picture of the state of sidereal science when the last quarter of the eighteenth century began. "It included," she says, "three items of information: That the stars have motions, real or apparent; that they are immeasurably remote; and that a few shine with a periodically variable light. Nor were these scantily-collected facts ordered into any promise of further development. They lay at once isolated and confused before the inquirer. They needed to be both multiplied and marshalled, and it seemed as if centuries of patient toil must elapse before any reliable conclusions could be derived from them. The sidereal world was thus the recognised domain of far-reaching speculations, which remained wholly uncramped by systematic research until Herschel entered upon his career as an observer of the heavens."

And now we have entered on the first quarter of the twentieth century, and the intervening years have been as many centuries in the multiplication of facts and fancies in this same sidereal science. All the greater need that they should be marshalled and passed in review; that fact should be joined to fact in a promise of further development; that proved fact should be disjoined from unproven fancy lest the two together should point out a wrong conclusion, and knowledge be darkened in a confusion of words. This gigantic task Miss Clerke first undertook in 1885, in her first edition of this book. A second edition followed, and a third in 1893. The nine years which followed witnessed such a march in almost all the branches of astronomy that in her fourth and present edition Miss Clerke has found it necessary to rewrite the book almost from cover to cover. That the volume does not bulk larger than the previous editions is due to the smaller print and thin paper which the publishers have used.

Miss Clerke's qualifications for her task are unique. The first requisite—patient industry—has been pre-eminently hers. The thoroughness with which she worked over the ground covered by the astronomers of the earlier part of last century, and the persistency with which she has kept her finger on the pulse of the science, from the time when she first commenced the work, are most remarkable. But the "History" is far indeed removed from any mere dry-as-dust compilation, for with rare judgment she orders fact and theory in their due proportions, pointing out their accordances, discrepancies, and contradictions; the accordances which establish the truth of a theory; the contradictions between fact and theory that cry out for the reconstruction of the latter; the discrepancies which so often point out the openings to new avenues of knowledge. But great research and rare judgment may be, and indeed often are found together in a book that is almost unreadable, through the writer's powerlessness of expression. But not here, for Miss Clerke's literary skill and brilliant style are even more apparent than her industry and judgment. It may be possible to find here an important observation overlooked, or there a wrong conclusion, but throughout the whole volume it would be impossible to find a dull page or an ambiguous sentence.

Where the whole is so excellent it may seem somewhat ungracious to call attention to what is perhaps little more than some dust on the balance, but Miss Clerke herself has led the way for its removal by reversing many of the conclusions recorded in the earlier editions.

One of these conclusions still finding place in the fourth edition is the too close connection claimed for Carrington's and Hodgson's "white patches" of solar light on September 1, and the magnetic disturbances of the same day. It is true that a great magnetic storm raged from August 28 to September 4, but at the actual time of Carrington's observation there was a lull in this storm, and, as Mr. Ellis pointed out in *Nature* for 1893, the magnetic trace was but disturbed by a small "twitch" of such a common and ordinary character, that we cannot believe that it was any direct result of the solar outburst. Such "twitches" have been noted since at all periods of sunspot activity, but Carrington's observation has never been repeated.

In another case Miss Clerke fails to see the force of her own reasoning with respect to the constitution of the planet Venus. In one place she says:—"We are almost equally sure that Venus, as that the earth is encompassed with an atmosphere." In another, when discussing spectroscopic observations of the planet: "Some additions there indeed seem to be in the thickening of a few water and oxygen lines; but so nearly evanescent as to induce the persuasion that most of the light we receive from Venus has traversed only the tenuous upper portion of the atmosphere. It is reflected at any rate with comparatively slight diminution." And again: "The reflective power of Venus must be singularly strong. And we find, accordingly, from a comparison of Zöllner's with Müller's results, that its albedo is but little inferior to that of new-fallen snow; in other words, it gives back 77 per cent. of the luminous rays impinging upon it." Now it is evident from these observations that we do not receive light from Venus herself, but only from the outer surface of her atmosphere, and that therefore it is not possible for us to see the configuration of the planet's crust. Miss Clerke acknowledges this, but in the matter of the planet's rotation, she is overpowered by the positive assertions of careful and trustworthy observers that markings seen by them have altered their position; more especially is she influenced by the great names of Schiaparelli and Lowell. Since the publication of the "History," Mr. Lowell has withdrawn his observations of radiating markings on Venus, as evidence showed them to be subjective; and as for other observers, their many discrepancies seem indeed but to strengthen the theoretical position that we do not and cannot see the seas and continents of Venus and their rotation, be it fast or slow round her axis.

"JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES."—One of the most interesting papers in this volume is by Mr. G. H. Knibbs, F.R.A.S., on "The Principle of Continuity in the Theory of Space." The subject is treated with more lucidity than might have been expected where not only pure but pseudo-homaloidal space of n-dimensions is taken into account. It is obvious, as the author puts it, that if we define a point as of zero-dimension (as Euclid does) the continuous generation of a finite quantity by a finite number of additions is not a conceptual possibility. We cannot agree with him, however, that it is any less obviously inconceivable that such a quantity can be continuously generated by an infinite number of point additions. Where the zero is absolute, and not merely a quantity which is infinitely small, the summation of an infinite number of such zeros cannot result in the generation of a finite quantity, even though the infinity were of a very large order.

"OUR COUNTRY'S FISHES AND HOW TO KNOW THEM." By W. J. Gordon. (Simpkin.) Coloured plate. 6s.—This little book, compiled from various sources, is intended to be used as a key by those who may desire to identify the adult forms of any of our British fishes. The style of composition leaves much to be desired, to say nothing of accuracy. Thus we are informed that "the flat-fish start as very thin youngsters swimming the ordinary way up . . . . and their eyes in the normal places, one on each side of the head; but apparently, failing to thrive under these conditions, they betake themselves to the ground where . . . . their head turns over so as to bring both eyes on the top. . . ."! Again we read, "Some are said not to know a sole from a lemon sole: the only way out of the difficulty is to know what a sole is like, the lemon sole being what may be called various, and generally but a somewhat distant relative"! Minor inaccuracies are of course inevitable, they will creep in despite the greatest care; on these then we will be silent.

BOOKS RECEIVED.

Practical Photo-Micrography. By Andrew Pringle, F.R.M.S., &c. (Iliffe.) Illustrated. 3s. 6d. net.

Man. II. 1902. (Anthropological Institute.) Illustrated. 12s. net.

First Stage Botany. (Organized Science Series.) By Alfred J. Ewart, D.SC., PH.D., F.L.S. (Clive.) Illustrated. 2s.

Atlas of Popular Astronomy. By Thomas Heath, B.A. (W. & A. K. Johnston.) Illustrated. 7s. 6d.

Electrical Installations. By Rankin Kennedy, C.E. Vol. III. (Caxton Publishing Co.) Illustrated.

Qualitative Analysis. By L. M. Dennis and Theodore Whittelsey. (Ginn & Co.) 4s. 6d.

Light for Students. By Edwin Edser. (Macmillan.) Illustrated. 6s.

Waves and Ripples in Water, Air and Æther. By J. A. Fleming, M.A., D.SC., F.R.S. (S.P.C.K.) Illustrated. 5s.

Year-Book of the Scientific and Learned Societies. (Chas. Griffin.) 7s. 6d.

Text-Book of Palaeontology. By Karl A. Von Zittel. Vol. II. (Macmillan.) Illustrated. 10s. net.

Jena Glass and its Scientific and Industrial Applications. By Dr. H. Hovestadt. (Macmillan.) Illustrated. 15s. net.

Celestial Mechanics. By F. R. Moulton, PH.D. (Macmillan.) 14s. net.

Annuaire Astronomique et Météorologique, 1903. By Camille Flammarion. (Paris: Librairie Ernest Flammarion.) 1 fr. 50.

The Master and his Method. By E. Griffith-Jones, B.A. (Hodder & Stoughton.) 1s. net.

The Shroud of Christ. By Paul Vignon, D SC.(FR.). (Constable.) Illustrated. 12s. 6d. net.

Report on the Total Solar Eclipse of January, 1898. By Kavasji Dadabhai Naegamvala, M.A., F.R.A.S. (Bombay: Government Central Press.) 8s.

Monthly Weather Bureau. (Washington: Weather Bureau.) 20 cts.

First Book of Forestry. By Filibert Roth. (Ginn & Co.) Illustrated. 3s. 6d.

Natural Law in Terrestrial Phenomena. By William Digby, C.I.E. (Hutchinson.) Illustrated. 6s. net.

Man's Position in the Universe. By W. Sedgwick. (George Allen.) 6s. net.

"Daily Mail" Year Book. 1s.

Preparatory Lessons in Chemistry. By Henry W. Hill. (Allman.) 1s. Illustrated.

Bible Records of the Earth's Changes. By Joseph Lewin. (Douglas: *Manx Sun* Office.)

Englishwoman's Year Book, 1903. (A. & C. Black.)

Who's Who, 1903. (A. & C. Black.)

Whitaker's Almanack, 1903. 2s. 6d. net.

Whitaker's Peerage, 1903.

Biological Laboratory Methods. By P. H. Mell, PH.D. (Macmillan.) Illustrated. 6s. 6d. net.

Electrical Problems. By William L. Hooper, PH.D., and Roy T. Wells, M.S. (Ginn & Co.) 6s.

XUM

Story of Alchemy and the Beginnings of Chemistry. By M. M. Pattison Muir, M.A. (Newnes.) Illustrated. 1s.
Penrose's Pictorial Annual, 1902-3. (A. W. Penrose & Co.)
Symons's Meteorological Magazine, December, 1902. (Stanford.) 4d.

THE NOBODIES,—A SEA-FARING FAMILY.

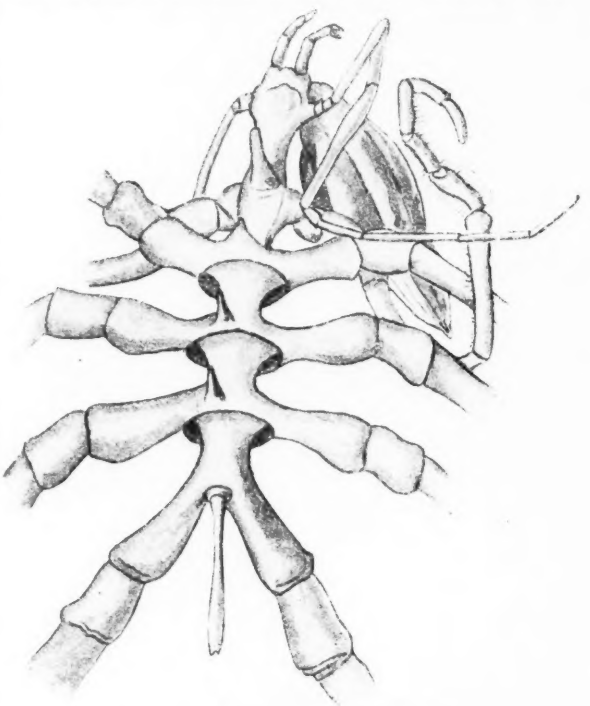
By the Rev. T. R. R. STEBBING, M.A., F.R.S., V.P.L.S., F.Z.S.

CHAPTER V.

A MAN is said to pocket an affront when he demurely lets it pass as though it had not been offered. The "chela-concealing" Cryptochelata have no pocket-like cavities within which to hide their nippers. They either let them vanish altogether, or retain them like superannuated dimples as an ineffective reminiscence of infancy. In classification, however, these disestablished or disendowed chelifori are still useful. They serve to discriminate three families of this section. In the Ammotheidæ they are small, rudimentary, and, in contradiction to their title, not cheliferous. They are small also in the Eurycydidæ, but there imperfectly chelate. In the Colossendeidæ they are entirely wanting. It will not be forgotten that these distinctions apply to the adults, the appendages in question being, so far as is known, present and chelate in the young of all the Pycnogonida.

In the first of the three families above mentioned there are several genera, exactly how many it is not easy to say, because some that are imposing in name are very obscure in nature. Thus *Oiceobathes*, Hesse, "with its home in the abyss," is perhaps the same as *Ammothea*, of which two species have their home on our own shores and shallows. *Pephredo hirsuta*, described by Goodsir, from the German Ocean, is thought by Hoek to be generically the same as *Phanodemus* which Costa instituted earlier for species from the Bay of Naples. *Clotenia*, Dohrn, and *Discoarachne*, Hoek, are, in the opinion of Dr. Hoek himself, closely approximate. They were published in the same year, 1881. Both authors date their work in the same month, Hoek on May 19th, at Leiden, Dohrn on May 31st at Naples. But although Dr. Hoek's "Challenger" report, as he subsequently explained, was ready to appear at the beginning of July, it was not actually issued till October, whereas Dr. Dohrn's Neapolitan monograph was at the service of the public in the preceding September. But the dates are perhaps not the only consideration. In *Clotenia* we find the chelifori dwarfed each to a little stump or tubercle. In *Discoarachne* not even so much as this is either mentioned or figured, so that the name must not be cancelled as a synonym without demur. The disappearance of these little vestigial stumps would probably make no difference to the animal. Nature would view it with unconcern. But the neat simplicity with which our three families have been discriminated will be very much disfigured by it, for the total absence of the chelifori is used as a mark of the third family, not of the first. To put the matter, then, on a broader footing, some supplementary characters of the Ammotheidæ may be given. They have the second appendages from four- to nine-jointed, the ovigerous legs seven- to ten-jointed without claws, and the ambulatory legs provided with auxiliary claws on the back of each principal claw or unguis. Of the genera not hitherto mentioned, *Paribœa*, Philippi, 1843, is obscure. So is *Platychelus*, Costa, 1861, which has, moreover, a preoccupied name. *Tanystylum*, Miers, 1875, takes its title from its tail, which is described as "a long styliform process." *Lecythorhynchus*, Böhm, 1879, is so called from its "flask-shaped proboscis," while *Oorhynchus*, Hoek, 1881, has the "proboscis egg-shaped." In the latter year another new genus united the names of the last two authors, being called *Böhmia* by Hoek in honour of Böhm. Whether *Trygæus*, Dohrn, 1881, is named "full of lees" from the wine-coloured intestinal canal is a riddle which its author leaves for the ingenious to solve. Dr. Dohrn, in 1884, regarded Ammothea, Phanodemus, Pephredo, Pasithoe, Endeis, Pariboea, Platychelus, Alcinous, Achelia, as nothing but names of a single genus. It has been already explained that the last is, in fact, the adult form of the first, but the rest are still indeterminate, and of the species assigned to them it is not certain that all belong to the same family.

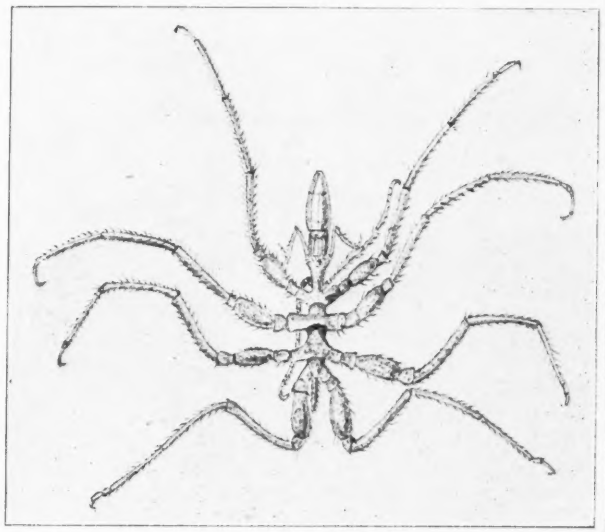
In place of Kröyer's *Zetes*, which was preoccupied, Schiödte introduced the name *Eurycyde*. The first half of this means "broad," and is applicable to the type or premier species of the genus, since the side processes of its trunk-segments are unusually produced, and therefore give a considerable total breadth to the body. But *cyde* is not Greek for a "side," and in the less impossible sense of "glory," the application remains a glorious uncertainty. Be the full meaning of the name what it will, this is the titular genus of the family Eurycydidæ. With the chelifori as already described, this family combines ten-jointed second and eleven-jointed third appendages, the terminal joint of the third being a claw. Auxiliary claws



Ascorhynchus glaber, Hoek. From Hoek.

are not found on the ambulatory legs. The proboscis has the remarkable habit of folding under the body. This peculiarity has been further illustrated in earlier chapters (pp. 75, 138 [1902]). It is also alluded to in the name of *Gnamptorhynchus*, instituted by Böhm in 1879, as the genus of "the bent beak," for a species from Japan. Hoek proposes to make this a synonym of *Ascorhynchus*, Sars, 1876, a doubtful proceeding, since the species described by Sars has the claw of the walking-legs elongate, while the Japanese species is unique in having no claw at all in the first pair of these limbs. Nevertheless, it must be remembered that in two species of

Ascorhynchus which Hoek describes, the claw on these first legs is either very small or "extremely minute." For introducing these confusing links and gradations into our genera we do not pretend to praise nature. We are only describing it. But there is another perplexing circumstance. In the *Ascorhynchus abyssi* of Sars, and the nearly related if not identical *A. tridens* of Meinert, the unconscionable female, instead of having the egg-cells in the fourth joint of the walking-legs, where by rule they ought to be, has them in the second joint. Now here the three species described by Hoek leave us in the lurch, for of two of them only the males are known, and the third, which he calls *Ascorhynchus orthorhynchus*, ought perhaps to be transferred to a new genus, since the solitary female



Ascorhynchus tridens, Meinert. From Meinert.

specimen from New Guinea will not bend its proud proboscis like the other species, and, on the other hand, it has the fourth joint swollen in accord with custom. In this family Sars is disposed to believe that *Alcinous*, Costa, *Parazetes*, Slater, and *Nymphopsis*,* Schimkewitsch, should also be comprehended. *Scœorhynchus*, Wilson, is identified with Ascorhynchus by Hoek.

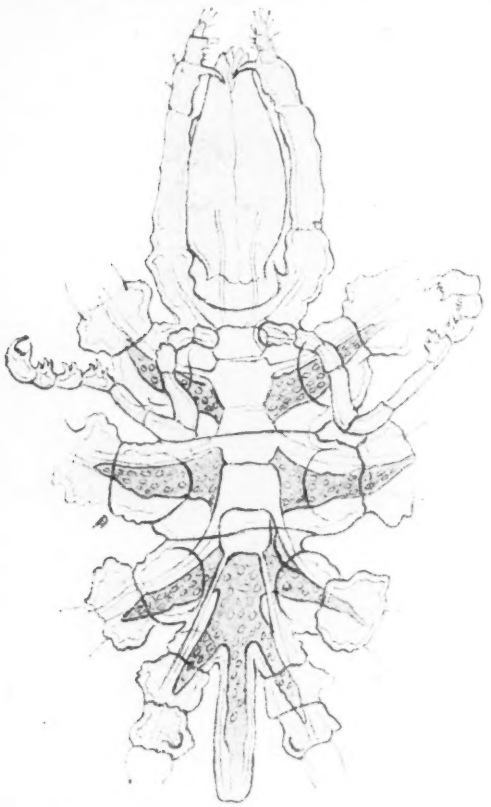
The remaining family is in some respects the most eccentric and remarkable of all. The members of it, as already explained, have in the adult no chelifori, our last pycnogonid family being so far in agreement, in rather unfortunate agreement, with the families that were placed first forming the section Achelata. But unlike the latter they are fully provided with second and third appendages. This family has been called Pasithoidæ by Sars, on the ground that *Pasithoe*, Goodsir, 1842, though imperfectly known, yet "from the perfect absence of chelifori and the well-developed palpi" must be included in it. But Goodsir's *Pasithoe* may not impossibly be an *Ammothea*, as Dohrn supposed, with the small chelifori overlooked. In 1844, Goodsir mentions a thin narrow projection arising from the anterior edge of the first segment immediately before the ocular tubercle, and continued beyond the middle of the rostrum. That his original account of *Pasithoe* needed revision is thereby made clear, and the narrow projection may refer to the chelifori indistinctly perceived. At both dates he plainly declares that the palpi, or second appendages in his genus are eight-jointed. But Sars defines the family as having the palpi ten-jointed. The genus *Endeis*, Philippi, 1843, has two

Pasithoe vesiculosa, Goodsir. From Goodsir.

species, but their family affinities also are distractingly vague. In common with Goodsir's *Pasithoe vesiculosa* they are still awaiting re-discovery and re-description. That happy events of this kind are not beyond the reach of scientific expectation derives some warrant from the strange case of *Rhynchothorax mediterraneus*, O. G. Costa, 1861. The Italian zoologist endowed this little creature with one feature so unexampled in the tribe that among the best judges of probability it was frankly disbelieved. He attributed to it a seven-jointed tail-piece. Even the two-jointed tail which the accurate Kröyer described in *Eurycyde hispida* was illusory, the appearance of an articulation depending only on a transverse series of dorsal setæ. At all events the specimens which Dr. Dohrn identifies with Costa's *Rhynchothorax* have the abdomen or tail simple, as it is in all other well-established Pycnogonida. The first of these specimens which Dohrn had the good luck to obtain from dredging at Naples he had the ill luck to lose before he had examined it with care. Every naturalist will sympathise with the pangs of regret he must have suffered, till at a later period other specimens from the same locality came to his relief. Dr. Hoek says: "On comparing the figures of Costa with those of Dohrn, one scarcely knows which is the more striking, the differences or the resemblance; nevertheless Dohrn has identified his species with Costa's, allowing himself to be guided above all by the general impression, and therein, I believe, he has been well advised." In the later and more trustworthy description, no less than in the earlier, there are some highly peculiar features. The front part of the proboscis is imperfectly developed. The ocular eminence stretches forward in a thin process over and beyond the centre of the proboscis. The second appendages are eight-jointed, with anchylosis of the first and second, of the fourth and fifth, and of the sixth and seventh joints. The walking legs have no cement glands in the fourth joint, which is their usual position, but only in the third joint of a single pair, the last but one. The cœcal prolongations of the intestine carry their gland-cells no further than the first, or at most the third joint of the legs, the continuation beyond this being limited to an empty membrane. The ovaries are peculiar by want of peculiarity, eccentric by being commonplace. For, whereas it is the badge of all their tribe to develop ova at least in some joint of the ambulatory limbs, this species is so faithless to the traditions of its race as to have ovaries not extending beyond the lateral processes of the trunk segments. The genital openings are limited to the last pair of legs as in *Pycnogonum*. We may either agree, then, with Dr. Dohrn that Rhynchothorax is the most remarkable of all the Pycnogonida, or we may leave it to

* An Australian genus, *Nymphopsis*, was founded by Haswell in 1885 (*Proc. Linn. Soc. N.S. Wales*, Vol. IX., pt. 4).

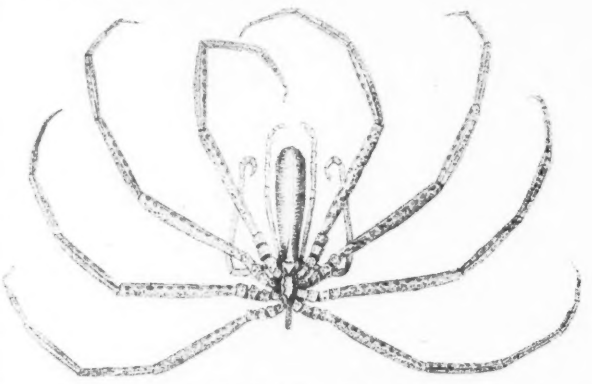
dispute the palm of singularity with Pycnogonum, since the latter has dispensed with a heart and second appendages which the former retains. Both these genera



Rhynchothorax mediterraneus, Costa. ♀ From below, legs omitted From Dohrn.

are included by Dohrn in the same family. Sars transfers Rhynchothorax to his Pasithoidæ, without commenting on the diminished number of joints in its second appendages, or on the various eccentricities which seem to demand for it a separate family, Rhynchothoracidæ.

There is still to be considered a genus which, if not the most abnormal, is from some points of view the most extraordinary of all the group. This is the genus of the giant proboscis. It agrees with the Eurycydidæ in having ten-jointed second, and eleven-jointed third appendages, but differs from them in the total absence of chelifori, and in not having its snout flexibly connected with the trunk. The first species of it made known to science was obtained within the Arctic Circle during Parry's first voyage of discovery. The specimen was "found at ebb tide on the shores of the North Georgian Islands." This was described by Sabine in 1821 under the name *Phoxichilus proboscideus*. It was subsequently transferred to a new genus, *Colossendeis*, by Jarzynsky in 1870, and before this name had obtained currency it successively received two others, *Rhopalorhynchus** from Wood-Mason, and *Anomorhynchus* from Miers, the former implying that the proboscis is as massive as a club, and the latter that it is what Dominie Sampson would have called "prodigious." The length of the adult *Rhynchothorax mediterraneus* is a millimetre and a half, about a sixteenth of an inch. Of *Colossendeis proboscidea* (Sabine) the original description says: "proboscis more than twice the length of the body, being one inch eight-tenths, and the body three-quarters of an inch long." The length of the legs is given by Sabine as six inches, which would



Colossendeis proboscidea (Sabine). Reduced. From Sars.

therefore afford a total span of more than twelve. Sars claims for the animal only a length of two inches with a span of nine. But *C. gigas*, Hoek, from great depths in the Southern Ocean, far surpasses either of these sets of measurements, since the animal can attain a length of over three inches with a span of more than twenty-four. To display this creature life-size with its ambulatory limbs unfolded and not overlapping, would require a double-page plate of this magazine. The species of the genus are numerous, and as they have generally been obtained from considerable or very great depths, one may surmise that there is some correlation between their length of limb and the character of their abode. Where the sense of sight has but scanty chances of employment, an extended organ of touch may be very useful, and this will help to explain the parallel case of deep-sea crustaceans, in some of which the antennæ seem ambitious of emulating telegraph wires. Nevertheless, as it happens, it is the short-limbed *C. brevipes*, Hoek, that is recorded from the deepest station of all, 2650 fathoms. The torrid temperature of more than 70° Centigrade, assigned to this abyss in Dr. Hoek's "Challenger" report, is due to a slight confusion. As may be seen from the "Narrative of the Cruise," though the surface water at this station was moderately warm, 70·8° Fahrenheit, the water at the bottom was only a little above freezing point, 32·7° F. Besides its colossal blunt proboscis, *Colossendeis* has various other notable characters. Meinert has remarked the retention of the chelifori by the young of *C. angusta*, Sars, when these juveniles were already more than half-an-inch long. Hoek has drawn attention to the circumstance that the ovigerous legs have not been found carrying ova in either sex. These limbs attain a great length, and shew no sexual difference. In the ambulatory limbs the terminal joint is not here unguiform but awl-shaped, that is, more of a needle than a hook. For what appear to be just reasons, Pasithoe, Endeis, Rhynchothorax have been dismissed from any close alliance with this genus. The family, therefore, in which it stands alone, must take from it the title Colossendeidæ already accepted by various authors.

That there is anything like finality in the classification here adopted, with a few modifications, from Prof. Sars, is not to be expected. All that can be safely assumed is that this is at least as good as any of the several systems hitherto offered, and in the existing state of knowledge the

* This, however, is upheld as distinct by G. H. Carpenter.

most convenient of them all. There is in Scotland a celebrated seat inviting wayfarers to "rest and be thankful." In its high and exposed situation this is sometimes surrounded by a guard of Highland cattle, which by their sturdy attitude seem planted on purpose to discourage indolence. In our pursuit of the Pycnogonida, readers may well think that by this time we must certainly have reached a point if not for gratitude at least for justifiable lassitude. But a final call is to be made on their endurance. The subject itself is in a stage more suggestive of energetic advance than of somnolent repose. In the concluding chapter, therefore, some notes will be offered as to the opportunities which our own country clearly offers for its investigation, and on the literature which is essential for any one anxious to carry forward research instead of re-discovering what is already known.

FAMILIAR BRITISH WILD FLOWERS AND THEIR ALLIES.

By R. LLOYD PRAEGER, B.A.

I.—THE PEA FAMILY.*

THE Order *Leguminosæ* is one of the great plant-groups of the world, myriad in number, ubiquitous in distribution, embracing every kind of plant from tiny herbs to gigantic forest trees, and abounding in useful and hurtful products and properties. As food-producing plants, it is the seeds that are chiefly used. These, enclosed in the *pod* that is so characteristic of this Order, and each containing a good store of food-material for the use of the young plant, are familiar to us as peas, beans, lentils, and haricots. As fodder for domestic animals, the whole plant is valuable in the case of the Clovers, Vetches, Lucerne, Sainfoin, and some of the Lupines. Among drugs, senna is prepared from the leaves of several tropical and sub-tropical species of *Cassia*; and liquorice from the root of *Glycyrrhiza*, cultivated largely in South Europe. Several important gums (gum tragacanth, gum arabic, &c.) are prepared from the juice of species belonging to this Order; other species yield well-known dyes, of which the most important is indigo, prepared from the leaves of tropical species of *Indigofera*. Nor must we omit the numerous species which, both in our fields and our gardens, are conspicuous for their beauty—the Gorse and Broom, Laburnum and Wistaria, the various Acacias and Genistas, the brilliant Clianthus, the Lupines and Coronillas.

This great Order is divided into three sub-orders—the *Papilionaceæ*, *Cæsalpinieæ*, and *Mimoseæ*, and to the first of these, the *Papilionaceæ*, characterized by their peculiarly formed irregular flowers—the familiar Pea-flower—belong all our British species. We have in these countries some seventy-two native representatives of the group, and various others, mostly indigenous in the adjoining parts of Europe, have been introduced accidentally or deliberately by man, and have now made themselves at home among the native forms. None of our plants are arboreal, but the Broom, Gorse, and Genistas furnish a group of shrubs dear to every lover of English landscape. The Vetches and Vetchlings form a coterie of exquisitely graceful and highly interesting climbing plants; while the Clovers, Medicks, Bird's-foots, and their allies constitute an important part of the dense low vegetation of our meadows, banks, and wastes. Among our British *Leguminosæ* are found a remarkably interesting series of morphological and physiological characteristics of varied significance, and pertaining to almost all the different parts of the plant. These must now be briefly reviewed.

First, as to the roots. The roots of Peas, Beans, Medicks, Clovers, and others are remarkable for being the seat of a highly interesting symbiotic union—a living together of two organisms for their mutual advantage; a kind of mutual partial parasitism. If the roots of any of these plants be examined, they will be found to be knotted with small tubercles. The function of these curious structures has previously been briefly referred to in KNOWLEDGE (October, 1900) by Mr. H. H. W. Pearson. It is found that these root-swellings are the home of colonies of bacterial organisms. These lowly plants are extremely minute in size and simple in structure, consisting of rows of cells. They increase by the production of spores, or by the simple dividing of the parent. Bacteria possess an important power not possessed by the *Leguminosæ*, though these are so much higher in the scale of life; they can absorb that important constituent of plant-food—nitrogen—directly from the air. By encouraging the growth of these bacteria, then, the plant has at hand a store of nitrogen which it can plunder. The bacteria, on the other hand, live on the sap and cell-contents of the plant which they infest; so both derive an abundant supply of valuable food-material as a result of the partnership. But the existence of bacteria is not necessary for the life of their partners. Peas or Beans grown in a sterilized soil will flourish, but no doubt they have to work the harder for it. Whether the bacteria can, in their turn, maintain permanent independent existence does not appear to be yet known.

From this curious feature of the roots of many of our *Leguminosæ* we pass to a study of their leaves. The reduction in size, or practical suppression, of the leaves of our shrubby species is a remarkable feature. The three native species of *Genista* have, in lieu of the ternate (consisting of three leaflets) or pinnate leaves which characterize the Order, small entire ovate or lanceolate leaves; the well-known Broom has, indeed, ternate leaves, but they appear ridiculously small in comparison with those of other shrubs of similar dimensions—Brambles or Willows, for example. In the Gorse, the reduction of leaf is carried further, and each consists merely of an inconspicuous spine a quarter of an inch long. Studying these plants one will be struck by the green colour of their stems, and thus we discover how they contrive to manufacture sufficient plant-food in the absence of expanses of green leaf; the surface of the stems take up the work usually carried on by leaves. In the Needle Furze (*Genista anglica*), and conspicuously in the Gorse, the reduction of leaf-surface is accompanied by a production of spines. In the Gorse the stems are very much branched, and every branchlet ends in a strong spine, its point wonderfully sharp and hard. This formidable array of bayonets has for its object the protection of the plant against grazing animals, and its efficacy is seen in the way the Gorse grows fearlessly on upland pastures, steadily increasing if not cut down, and pushing back the cattle and sheep year by year. That such protection is necessary to the plant is shown by the avidity with which animals will eat it if it is crushed. In some parts of the country such crushing is done regularly as an item of farm economy, as the accompanying photograph, taken in Co. Antrim by my friend Mr. Welch, will show. The plant then furnishes excellent fodder.

In contrast to this comparative unimportance of the leaf, we have in the Vetches and Vetchlings large pinnate leaves which are highly developed, and possessed of a sensitiveness and power of movement that are most remarkable. These Vetches form a group of highly

* For the use of the illustrations which form Figs. 2, 3, 4, and 5, the writer expresses his obligations to Messrs. C. Griffin & Co. They are taken from his "Open-Air Studies in Botany."

specialized climbers. Climbing is a device resorted to by many of our native plants, and by a far larger number in the Tropics, by which, in the keen struggle for light and air, they take advantage of their neighbours to mount on

FIG. 1.—"Knockin' Whins" for Cattle, Co. Antrim.
[R. WELCH, *Photo.*

their shoulders, and thus secure an advantageous position. To assist them in climbing, plants adopt various devices, some merely scramble upwards, maintaining their position by means of wide-spreading leaves or branches; many others use downward-pointing hooks, which anchor them amid the foliage. It is in the twining plants, such as Bryony and Hop, and the tendril-bearers, like the Vetches, that we find the highest development of the climbing habit. These plants live under unusual conditions. In order to gain the light, they must seek, rather than avoid, overhanging foliage; and so we find the Vetches, instead of turning away from the shadow towards the light like most of their neighbours, boldly pushing up into the centre of a bush, to burst into blossom amid its upper branches, far above their less daring neighbours. Again, in these plants, supported by their grasp of adjoining branches, the stem no longer needs to act as a supporting column, bearing the weight of the plant and the stress of weather. It acts rather as a conduit through which water and dissolved salts—the raw plant-food—passes upwards to the leaves. Hence, instead of being thick and stiff, it is thin and flexible; often wonderfully slender when we consider its length, yet strong and supple, to follow without injury the swaying of the supporting plant. But it is in the leaves of these plants that we find the most remarkable modifications adapting them to a climbing habit. The leaves of the Vetches and Vetchlings are pinnate—they bear a number of opposite ovate leaflets. The tip of the leaf-stalk, and the uppermost pair of pinnæ, are in the climbing species changed into tendrils—sensitive, twining, whip-like structures, which exhibit remarkable features. If the slightly curved, extended tendril of a young leaf of Pea or Vetch be watched carefully, it will be found that it is slowly but incessantly moving round and round in a circle. If the tendril comes into contact with a twig, it bends towards it, and eventually takes several turns round it. Even a slight temporary irritation is sufficient to cause a bending towards any side. Finally the tendril becomes woody and strong, and forms a secure anchor-cable for the plant. Not only does the young tendril rotate; the whole leaf on which it is borne is in continual motion. The shoot to which the leaf belongs is rotating also, so that the tendril is sweeping the air with a complicated motion, in the course of which it is almost sure to strike against some stem or twig of the surrounding vegetation. It is interesting to note that a few species of these climbing genera are low-growing, make no attempt to climb, and that in these, tendrils are not developed. Such are the Wood Bitter Vetch (*Vicia Orobus*), which grows in bushy clumps, and the tiny Spring Vetch (*V. lathyroides*), whose home is on short sandy turf. Also the well-known Tuberous Bitter Vetch (*Lathyrus macrorrhizus*), and the Black Bitter Vetch (*L. niger*). In all these the stem terminates neither in a tendril nor in a leaflet, but in a short point. Two other native species of *Lathyrus* possess peculiar leaf-modifications which are worthy of study. In the Grass-leaved Vetchling (*L. Nissolia*) no leaflets are produced, and instead the leaf-stem which usually bears them is expanded into a narrow flat leaf, which so nearly resembles those of the grasses among which it grows that it is almost impossible to detect the plant when it is not in flower. The seed-pods also are long, narrow, and green, and only the solitary rose-red blossoms betray the presence of the plant. The Yellow Vetchling (*L. Aphaca*) has gone to another extreme. Its leaf is wholly converted into a long undivided tendril. To act as a substitute in the important work of assimilation, the stipules, which in the Vetchlings usually take the form of a pair of small leaf-like organs clasping the stem at the base of each leaf-stalk, are here enlarged, and form a pair of large triangular pseudo-leaves at each node. From the axil of the tendril-leaf springs the flower-stalk, bearing a single yellow blossom. To convince ourselves of this curious shifting of responsibility we have only to examine seedlings of the plant. We then find that just as the seedling Gorse shows true trifoliate leaves giving way to spines, so in this species the first leaf has a pair of leaflets, and is accompanied by a pair of stipules of the normal size and shape.

FIG. 2.—Leaf of Bush Vetch, *Vicia sepium*. Half natural size.

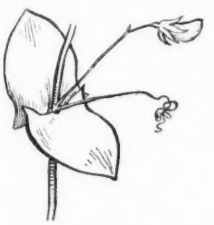


FIG. 3.—One Node of Yellow Vetchling (*Lathyrus Aphaca*.) Half natural size.

The familiar peculiarly shaped flower of, for instance, the Sweet-Pea, Broom, or Laburnum, is most characteristic of the sub-Order *Papilionaceæ*, to which belong all our British *Leguminosæ*. This flower is profoundly modified to suit the visits of insects, which effect cross-fertilization. The axis of the flower, as in most of the more highly specialized entomophilous flowers, is horizontal. The calyx is more or less cup-shaped, with five teeth of varying length, and it is persistent throughout the period of flowering and fruiting. The corolla consists of five petals. The upper one (the *standard*) is large and broad, often variegated with stripes of a second colour, and forms a kind of roof. Two narrower ones (the *wings*) are placed below, one on each side; and more or less enclosed by them, the fourth and fifth are slightly joined together along their lower margin, and form the *keel*. Ten stamens spring, like the

petals, from the base of the calyx-tube; their filaments are usually united in the lower portion into a tube, which surrounds the ovary; their free ends curve upwards, fitting the upward curve of the keel, along the bottom of which they lie. The ovary is one-celled, capped by the long style, which follows the curve of the stamens. The blossoms generally possess a brilliant colour—yellow and red being the prevailing tints among our British species—and an attractive odour. These flowers are essentially constructed to be fertilized by bees. The brilliant upcurved standard renders the flower conspicuous. The horizontal position of the flower fixes the manner of approach. The "wings" guide the insect in entering the flower to seek the honey, which lies on the inner side of the bases of the filaments. The mechanism for dusting the bee with pollen varies in different species. In the Clovers and others the weight of the bee causes the stamens and stigma to slide forward out of the keel, the stamens depositing pollen on the underside of the bee's body, while the stigma takes up pollen that may be adhering there in consequence of previous visits to other flowers. In the Genistas, Medicks, and Broom, the keel more tightly confines the stamens and pistil, which rupture the keel with explosive force on pressure produced by a bee's visit, dusting the insect with pollen. In Rest-harrow, Lady's-fingers, &c., there is a kind of piston mechanism, the stigma sliding forward and pushing out against the bee's body a small quantity of the pollen, which is shed by the stamens, and collects in the forward end of the keel. Finally, in Vetches, Vetchlings, &c., the style bears a brush of hairs, which similarly sweeps the pollen out of the keel against the body of a visiting bee. In the Broom, half the stamens are shorter than the others. When a bee alights on the flower, first the short stamens explode out of the keel, dusting the underside of the insect; then the long stamens spring out, and shed their pollen on the bee's back.

When the flower is fertilized, the ovary grows, and develops into the *pod*, which is so characteristic and well-known. In some genera, such as the Clovers, the petals do not fall, but remain, brown and dry, covering the short fruit; but in the more conspicuous cases the pod is long and bare. These pods have in many cases a peculiar method of sudden rupture, and consequent scattering of the seeds which they contain. When the seed is ripe, as the pod dries, certain strong-walled cells which run diagonally across each valve of the pod contract spirally, causing a torsion which eventually ruptures the pod with violence, each valve twisting spirally, and flinging the seeds to a distance. The burst pods of *Lotus corniculatus* will be found to have each valve twisted by several convolutions; and on a hot summer's day, amid a grove of Gorse the air is sometimes filled with the cracking of the pods as they explode. The seeds contained in these explosive pods are often comparatively heavy, the embryo being set between two ample pads of food-material; nevertheless,

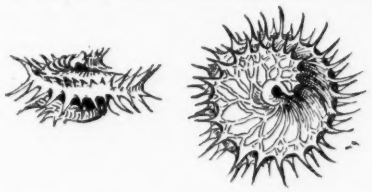


FIG. 4.—Fruit of Reticulated Medick, *Medicago reticulata*. × 3.

they are ejected to a considerable distance, and the seedlings grow up clear of the parent plant. A different mode of dispersal is adopted by many of the Medicks. The pod is curiously modified, being curled up in a close spiral, and furnished with numerous conspicuous curved spines. The spines cause the pods to become attached to passing animals—probably to their feet, for the plants grow low on the ground—and thus they become widely dispersed.

Finally, we may briefly pass, in review, the various British members of this interesting and beautiful Order of plants. Of the shrubby species, we have the Broom (*Cytisus scoparius*), the only British representative of a well-known Old World genus. Of Gorse there are three closely allied species (*Ulex europæus, U. nanus, U. Gallii*). The first occurs throughout our Islands, the second chiefly in the south of England, the third mostly in the west and in Ireland. Of the three Genistas (*G. tinctoria, G. anglica*, and *G. pilosa*), the first two range through England into Scotland, the third being a local southern English plant; all are absent from Ireland. Of Rest-Harrow (*Ononis*), there are likewise three species, of which two are wide-spread, the third, *O. reclinata*, being a small southern annual. The little Fenugreek (*Trigonella purpurascens*) is an anomalous plant that has had a temporary home in many genera; it is very local in distribution. The native Medicks are six in number, and show a great variation in their pods, which may be bare and nearly straight, or curled into a close ball and densely spiny. They are plants of dry places and waste ground, and have their head-quarters in south-eastern England, like most genera of similar proclivities. Of the pretty Melilots, only one species, *M. officinalis*, is reckoned native, but several others have colonized our country, or appear as ballast plants. The Trefoils (*Trifolium*) are the largest British genus of the Order, numbering eighteen native species, and half-a-dozen others more or less thoroughly established. Some of these, such as the well-known Red Clover (*T. pratense*) and Dutch Clover (*T. repens*), are valuable meadow plants; most of the others favour light soils or sandy ground. One, the

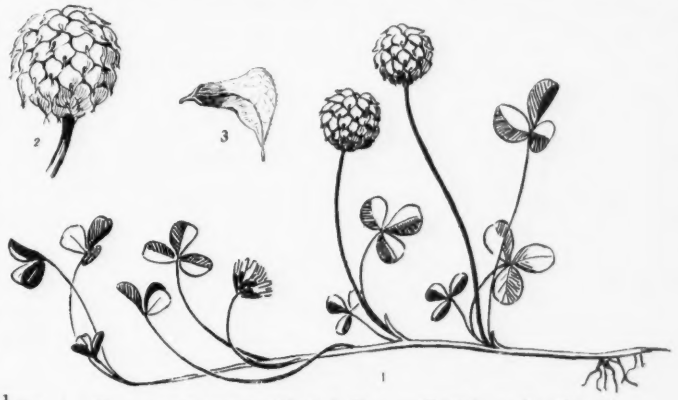


FIG. 5.—Strawberry-Headed Clover *(Trifolium fragiferum)*. 1, × ½; 2, natural size; 3, × 2.

curious Strawberry-headed Clover (*T. fragiferum*), chooses salt marshes; the fruiting heads of this species are rendered conspicuous by the way in which each calyx is inflated. Of Lady's-fingers (*Anthyllis*), the only British species is the well-known and widespread *A. Vulneraria*. *Lotus*, or Bird's-foot Trefoil, numbers five species, of which the rarest are *L. angustissimus* and *L. hispidus*, both confined to the south of England. The most familiar is the delightful little *L. corniculatus*, which adorns dry banks, especially near the sea, with its elegant glaucous foliage and umbel-like clusters of fragrant yellow blossoms.

XUM

The Milk Vetches (*Astragalus*) are three in number, and exhibit a great diversity of habitat, the first (*A. glycyphyllos*) being a large meadow plant, the next (*A. hypoglottis*) a small chalk species, while the third (*A. alpinus*), and *Oxytropis campestris*, which comes next on our list, are the only British species of the Order which affect an alpine habitat, both growing very sparingly on the Scotch mountains at an altitude of 2000 feet or more. *O. uralensis*, our only other representative of the latter genus, is a small Scottish hill plant, which ascends nearly as high as its congener. The genus *Ornithopus*, Bird's-foot, has two species, pretty little sand or gravel plants with pinnate leaves. *O. perpusillus* has a wide distribution, while *O. ebracteatus* grows on the Scilly Islands. The Horse-shoe Vetch (*Hippocrepis comosa*) is a similar looking plant with curious wavy pods, wide-spread in England. The Sainfoin (*Onobrychis sativa*) is, like the last, the only British member of its genus. It is a handsome herb, a couple of feet in height, with pinnate leaves and racemes of rose-red flowers, in our islands confined to England, where it is not certainly native. Lastly we have the two large genera, the Vetches (*Vicia*) and Vetchlings (*Lathyrus*), which have been frequently referred to above. The climbing species generally grow, the lower among grass, the taller among shrubs, where they may attain in the season's growth a height of six or eight feet. The species devoid of tendrils grow in bushy form, or straggle upwards supported by neighbouring vegetation, or lie prostrate on the ground. The climbing species are the most picturesque of all our *Leguminosæ*. With their often winged ribbon-like stems, their graceful tendril-tipped leaves, and handsome clusters of blossom, they form delightful objects, and when we remember the beautiful and complicated structure of the flower, and the marvellous sensitiveness of the tendrils, we see and recognize in them some of the most highly developed forms to be met with in our whole native vegetation.

MICROSCOPY

Conducted by M. I. CROSS.

PHOTOGRAPHY OF OPAQUE OBJECTS.

By FREDERICK NOAD CLARK.

The method of procedure for this branch of Photo-micrography, in so far as the microscope is concerned, is practically the same as that for the photography of transparent objects. The difference lies chiefly in the mode of illumination, as well as in certain precautions to be observed in the mounting of the specimen, and in the purely photographic portion of the work.

At the commencement it is necessary that the object should appear in contrast to its background, the latter being selected with a view to this. A dark subject should have a light background, and *vice versâ*. For white objects, such as some eggs of insects, Foraminifera, etc., a disc of asphalt varnish placed on the glass slip with the turntable will be found suitable, the object being fixed thereon with a tiny spot of thin gum tragacanth. For darker subjects the under surface of a thick glass slip may be painted with white cement or enamel, the thickness of the glass minimising the effect of shadows cast by the illuminant. Should this not prove satisfactory a disc of white cardboard may be placed over the substage condenser a little distance behind the object, which in this case is mounted on a clear glass slip. Fair results may be obtained with specimens permanently mounted under a cover glass, but the best are made with those that have been freshly mounted without a cover.

Whenever possible objects should be photographed on their natural support. For example—the eggs of insects *in sitû* on the larval food-plant, leaf, bud, calyx, etc., the educational value of the result being thus enhanced. This, of course, is not always possible, for frequently, as in the case of insects' eggs, the objects lie in different planes. When two or more objects in a group are photographed it is essential that they lie in a plane exactly at right angles to the axis of the microscope tube, or trouble will result owing to difficulties in focussing. The following plan may be recommended: fix the objects on a cork cut perfectly flat on the upper surface, having its sides tapered off so as to fit the opening in the stage, it may then be readily adjusted in any position. If the object is mounted on a glass slip this may also be attached to the cork.

Dark ground illumination is effected in several ways. One method is by using the central spot diaphragms, the smallest of these which will give the required dark ground being inserted in the substage condenser. The exposure of the plate will necessarily require to be long. Another method sometimes employed is the reflector known as the "Lieberkuhn." It, however, has disadvantages, as a separate one is required for each objective, and the mount must be specially prepared with a circular black spot on the under side of the glass slip. The illumination also is not satisfactory, being too "general," and delicate structure is flooded with light when contrast is required. Probably the best method is in the use of the side silver reflector, the rays from a good paraffin lamp being condensed on its surface by means of the bull's-eye condenser. Excellent results have been obtained simply by using the bull's eye placed obliquely towards the object, and as closely as possible. These methods are, of course, only applicable to low-power objectives, the short focal distance of the higher powers not admitting of their use. When photographing with the higher powers up to one-twelfth inch the "vertical illuminator" must be employed. This is a piece of apparatus fitted into the microscope tube above the objective, the light being conducted thereto through a small aperture in the side of the tube. When this is used the object must be either uncovered or in absolute contact with the cover glass. We will not notice such devices as the spot lens, paraboloid, etc., for obtaining dark ground illumination, they having been superseded by the methods just described.

(To be continued.)

POND-LIFE COLLECTING IN JANUARY.—January is the most severe month of the year, and lakes and ponds are often frozen over, or difficult to approach. Microscopic Pond-life, though less abundant than in the spring and autumn, is nevertheless nearly always present, even under the ice many inches thick. All the following species of Rotifers have been taken in January in and near London, but, no doubt, a great many more could be found by systematic search: *Asplanchna brightwelli* and *priodonta*, *Anuræa aculeata* and *cochlearis*, *Brachionus pala* and *angularis*, *Notholca scapha*, *Euchlanis deflexa* and *hyalina*, *Rotifer macrurus* and *vulgaris*, *Polyarthra platyptera*, *Synchæta pectinata*, *tremula*, and *oblonga*, *Conochilus unicornis*, *Coelopus porcellus*, *Diaschiza lacinulata* and *ventripes*, *Proales decipiens* and *petromyzon*, *Diglena forcipata*, *Dinocharis pocillum*, *Monostyla cornuta*, *Colurus caudatus*, *Melicerta ringens*, *Limnias ceratophylli*, *Oecistes crystallinus*, *Floscularia cornuta*, and *Stephanoceros Eichhorni*. *Diaptomus* and *Cyclops* and their larvæ are abundant, whilst Waterfleas are almost absent. Aquatic vegetation having died down, the fixed forms of Rotifers and Infusoria should be looked for on the rootlets of trees growing near the edge of the water. *Floscules* and *Melicerta* were once found covering such rootlets very thickly. January seems to be the time when the males of *Stephanoceros* and other tube dwellers are often found, and their presence is usually betrayed by the thick-shelled, fertilized, resting eggs in some of the tubes, and numerous smaller male eggs in others.

THE MICROSCOPICAL WORK OF 1902 has been steadily progressive; there have been no great changes or discoveries, although many additions to and improvements in the detail of instruments have occurred and been duly recorded.

A feature that stands out distinctively is the increased

amount of interest that has been taken in metallurgical work, a department in microscopy which is destined to exert a great influence on metal work generally. The capabilities of the microscope in this direction are not yet completely realised, and we may look for further development in the near future.

Among other items the two-speed fine adjustments have created interest and three or four new models of microscopes have been introduced.

There is, undoubtedly, better understanding of the proper uses and applications of the microscope, the substage condenser and the objectives, and when once the principles of critical illumination are thoroughly grasped and practised microscopical work generally will be uniform and far more trustworthy. It is but a few years since some degree of eminence was accorded to a well-known histologist for his investigations of certain structure, and the supposed discovery of new facts and detail which he demonstrated by photo-micrographs; yet it was evident to those who worked "critically" that the new features were almost entirely introduced by errors of illumination, and this was proved when his methods of working became known. Yet his dicta were accepted, reviewed and praised.

In another case a microscopist, who worked according to modern knowledge and practice, was being examined for a degree, and, amongst other things, was called upon to "spot" a subject which he had for several years studied and made especially his own. Owing to the indifferent method adopted by the examiner in illuminating and arranging the microscope, he failed to identify the specimen until he had bethought himself to re-arrange the setting up. I make special reference to this subject because it appears to me to be a real desideratum that microscopists shall work in the most precise manner that is known; it is only as work is accurately done that it becomes of real value.

In the conduct of a column such as this, the variety of information given and the general usefulness could be greatly increased by the co-operation of readers.

As mentioned in the December number, arrangements have been made for articles by several specialists to appear, but beyond this there are many readers who have made some special department the subject of study for a long period, and are in a position to give directions and advice which would be invaluable to other microscopists. Others have had constructed to their special ideas pieces of apparatus which they have found serviceable, or have distinctive methods of working which are not generally practised by others.

Among instances of these might be mentioned the method of showing a living fly in the act of feeding which was devised by the late Mr. Macer, and the beautiful colour arrangements which Mr. Rheinberg has brought to such perfection.

Communications are cordially invited, and aided by the consultants who have kindly placed their services at the disposal of readers of this column, I shall be happy at all times to give every assistance and advice in my power to those who may wish to avail themselves of it.

WANTED A MICROSCOPE TABLE.—In the November number suggestions were invited for a comprehensive microscope table, which could be closed and left with work in hand, ready to be proceeded with at some convenient subsequent time.

I have received several suggestions, but undoubtedly the best of all is the table which Mr. T. H. Russell, of Edgbaston, had built to his own ideas some years ago. An illustration of it is appended.

The following are its dimensions: Height, 2 ft. 5 in.; measurement of top, 15½ in. by 24 in.

It also has a hinged flap, suspended from the back of the table, 11 in. wide, on which mounting, etc., is done.

The table is fitted with a drawer which is divided into some eighteen compartments, similar to the plan shown. In this are contained dissecting instruments, cover glasses, glass slips, spirit lamp, saucers, and general accessories.

The loose wooden lid or cover, about 3½ in. deep, fits over the top of the table, and is provided with two locks, one at each end, by means of which it can be fixed to the top of the table, and thus covers any work which may be in progress. Two strong handles are fixed to the sides of the table for lifting.

This table has one great merit—simplicity—and would undoubtedly cover the requirements of four-fifths of the working microscopists. It will be readily seen that it could be made, if desired, at a very moderate expense, and modifications to suit individual tastes and requirements could be readily introduced.

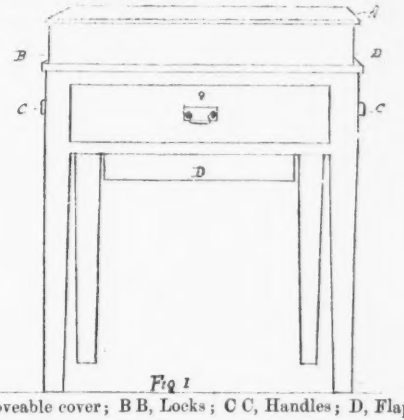


FIG 1

A, Moveable cover; B B, Locks; C C, Handles; D, Flap.

For those who cared to do it, it would, of course, be possible to raise the lid by means of a pulley wheel attached to the ceiling and a weighted cord; and if it were desired to leave the microscope in position, the shape of the cover could be made so that it would go down over the microscope and lamp *in situ*.

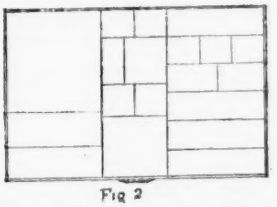


FIG 2

Plan of Drawer, showing divisions.

To minimise vibration, the feet of the table could be inserted in sockets padded with india-rubber.

Our correspondent has in addition a cupboard in his hall where various articles such as a supply of water, bottles, and receptacle for waste water, etc., are always at hand.

PRACTICAL SCHEME.—In continuation of the attempt made last year to foster practical work, material will from time to time be offered for distribution as hitherto. Through the courtesy of a reader I am able to offer some very interesting Spongilla and sponge spicules. A small supply will be sent to applicants on receipt of a stamped addressed envelope accompanied by the coupon to be found in the advertisement pages of this issue.

Mr. R. G. Mason, of Clapham, calls attention to his series of unmounted specimens, and has given me an opportunity of seeing the Limestone and Coal sections that he is advertising. The former would be found very useful to those who require practice in mounting; the prepared specimens are cleanly mounted and show interesting structure.

NOTES AND QUERIES.

C. M.—You are quite right, the deep curve of the crossed lens of an Abbe illuminator should be mounted downwards, that is, in the direction of the mirror of the microscope. The focus you mention is unusually long for an Abbe illuminator of correct form.

H. T.—I am afraid I cannot add to previous information. You ought easily to get a good black background under the circumstance you name, it is entirely a question of manipulation. Presumably you use the plane mirror. While you failed with the Abbe illuminator alone, there was a chance of something being wrong, but seeing that you do not succeed with a spot lens either, it seems certain that some little detail in your working is not attended to.

W. D. B.—The difficulty you mention of obtaining the same polarisation colour effects by artificial as with daylight is always a somewhat difficult matter. The only suggestion I can offer is that you set up a light filter consisting of a trough containing a blue medium of acetate of copper or ammoniacal solution of sulphate of copper, and then by varying the strength to find the tint which will give you the desired result. Perhaps some of our readers who do petrological work may know of some other and better method.

XUM

G. L.—I am afraid that I am unable to advise you in your attempt to prepare realgar specimens, the work is fraught with so much difficulty that it has been abandoned by nearly everyone; even those who do it professionally do not secure uniformity, some specimens keep for a number of years, while others decompose in a few days.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

COMET PERRINE (1902 B).—This interesting object is now necessarily relegated to the care of observers in the Southern hemisphere, as its position renders it invisible in high northern latitudes. Moving somewhat rapidly in a S.W. direction it has recently traversed Scorpio and Centaurus, and will occupy a position in about 46 degrees south of the celestial equator on January 22, thereafter returning northwards and again exhibiting itself above our English horizon early in February. The comet approached comparatively near to the planet Mercury on the morning of November 30 last, when the distance separating the two bodies was equal to 1,644,000 miles. The following is an ephemeris by Stromgren:—

Date 1903.			R.A. H.	M.	S.	Declination S. °	′	Light.
January	22	...	10	38	34	46	2	5·2
,,	26	...	9	46	17	43	58	4·7
,,	30	...	8	59	34	40	24	4·1
February	3	...	8	21	13	35	58	3·4
,,	7	...	7	51	16	31	16	2·7
,,	11	...	7	28	23	26	47	2·1
,,	15	...	7	11	2	22	42	1·6
,,	19	...	6	57	52	19	6	1·3
,,	23	...	6	47	54	15	58	1·0
,,	27	...	6	40	22	13	16	0·8
March	3	...	6	34	46	10	56	0·6
,,	7	...	6	30	53	8	54	0·4
,,	11	...	6	28	47	7	2	0·3
,,	15	...	6	28	49	5	13	0·2

After the first week in March the comet will finally disappear as an object for ordinary telescopes.

COMET TEMPEL-SWIFT.—No announcement appears to have been yet received as to the rediscovery of this comet. The calculations show that the present return to the perihelion has been much delayed owing to the disturbing action of Jupiter.

COMET SWIFT (1895 II.).—This comet was discovered by Lewis Swift on Echo Mountain on August 20, 1895, and though a faint object it was followed until February 5th, 1896, during which period about 400 observations were obtained. M. Schulhof has recently computed definitive elements, and remarks that "at the opposition of 1902 the comet will remain very faint; there may be hope, nevertheless, that it may be found with the aid of some of the more powerful instruments. There will be no possibility of observing it at its subsequent returns in 1910 and 1917. In 1924 its luminous intensity will be almost the same as in 1902, but the limits of uncertainty in its position will then be four times as great."

NOVEMBER LEONIDS.—Once more the month of November has come and gone without having furnished any striking meteoric spectacle, and it is now certain that the present generation must abandon all hope of witnessing a really grand exhibition of these meteors. Our experiences in and since 1898 have been singularly disappointing, and the (at least) temporary loss of the shower is to be deplored on several grounds. Its recurrence would no doubt have stimulated interest in the whole subject of meteors, while it would certainly have proved an incentive to the more thorough observation of these remarkable and numerous bodies. Apart, however, from special displays such as the Leonids occasionally produce it should be remembered that even on ordinary nights of the year the sky affords a vast and continuous exhibition of meteoric phenomena which patient and persevering observers may readily witness and record with pleasure to themselves and advantage to astronomy.

FIREBALLS.—November 3, 6h.—Mr. H. M. Cross, of Scarborough, saw a very brilliant meteor shoot across the heavens from east to west, leaving a long streak of light behind it.

November 9, 7h. 20m.—Mr. Ivor F. H. C. Gregg, of Cambridge, observed a fireball about two or three times brighter than Venus, moving very slowly, and leaving a fine streak. Path from 154° + 57° to 132½° + 54°; duration of flight, 4 seconds.

November 16, evening.—Very large meteor, with a trail of red light, seen at Berlin. The meteor burst low down in the western sky, and appeared like "a tremendous rocket."

November 25, 7h. 45m.—A splendid meteor, noticed by a casual observer at Bristol, moving rapidly in a north-west direction, and throwing off a long train of sparks.

December 2, 7h. 20m.—The Rev. S. J. Johnson, of Bridport, saw a meteor brighter than Venus passing slowly near the stars κ Draconis —ζ Ursæ Majoris. The meteor was greenish in colour, and it left a train. Duration of flight, about 2½ seconds. The observed course was from 187° + 71° to 203° + 57°, and the probable radiant near either α Persei or ε Arietis.

THE FACE OF THE SKY FOR JANUARY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 8.8 A.M. and sets at 3.59 P.M.; on the 31st he rises at 7.44 and sets at 4.44.

The earth is at its least distance from the sun at 1 A.M. on the 4th; the apparent diameter of the sun being then at its maximum, 32′ 35″·06; the horizontal parallax of the sun is then 8″·95, also a maximum.

Small groups of sunspots may be expected from time to time.

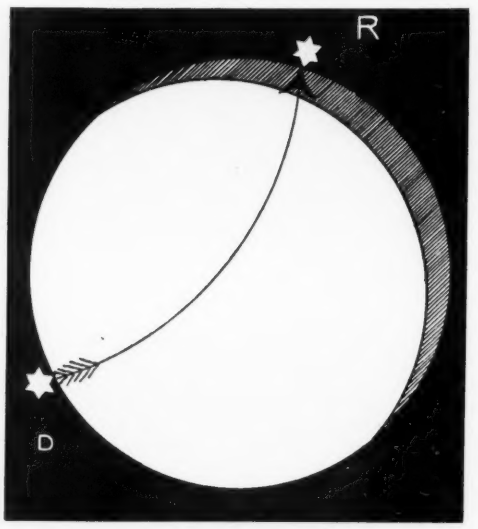
THE MOON:—

	Phases.	h.	m.	
Jan. 6	☽ First Quarter	9	57	P.M.
,, 13	○ Full Moon	2	17	P.M.
,, 20	☾ Last Quarter	11	49	A.M.
,, 28	● New Moon	4	39	P.M.

The moon is in perigee on the 13th, and in apogee on the 25th.

OCCULTATIONS.—The principal occultations visible at Greenwich are as follows:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
			h. m.	°	°	h. m.	°	°	d. h.
Jan. 12	26 Geminorum	5·1	4 0 P.M.	37	74	4 30 P.M.	323	1	13 19
,, 14	60 Cancri	5·7	7 30 P.M.	163	202	7 55 P.M.	219	259	15 22
,, 14	α Cancri	4·3	8 14 P.M.	78	118	9 8 P.M.	306	344	15 23



Occultation of α Cancri.

The diagram shows the occultation of the 4th magnitude star α Cancri. The letters D and R indicate the points of disappearance and reappearance.

THE PLANETS.—Mercury is an evening star in Capricornus; he attains his greatest elongation of 18° 45′ on the 18th, when he sets 1h. 45m. after the sun.

Venus is also an evening star, setting soon after the sun. On the evening of the 30th, when the planet sets at 6 P.M., she is in close conjunction with Jupiter, Jupiter being only 0° 44′ to the north; it is unfortunate that the planets set so soon after the sun, for it will only be possible to observe this exceptionally close approach in twilight.

Mars now rises before midnight; his path lies in Virgo, and on the morning of the 11th he passes to the south of γ Virginis by only a few minutes of arc. At 5 A.M. on the 19th the planet is in conjunction with the moon, Mars being 3° 35′ to the north. The gibbosity of the disc is considerable, the illuminated portion being 0·91 of the whole.

Jupiter is practically observable only during the first few days of the month, but the close conjunction of the planet with Venus on the 30th is interesting, and may possibly be seen in twilight.

Saturn is not observable, being in conjunction with the sun on the 21st.

Uranus is also out of range, being too near the sun.

Neptune is visible throughout the night. On the 1st he is very close to η Geminorum, having the same right ascension as the star, and being only 15′ to the south. Although the most distant of the planets, he hardly repays the trouble of finding; still it is an object that one wishes to have seen, and with the help of the accompanying chart the planet may be picked out from amongst the rich star-fields through which his path lies.

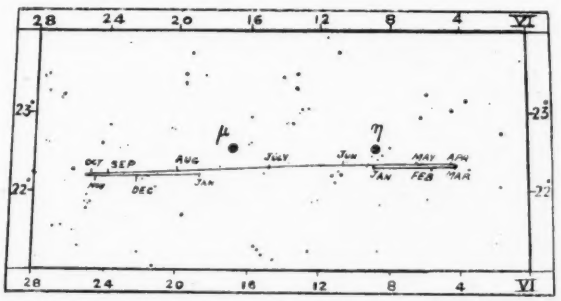


Chart showing path of Neptune in Gemini throughout the year 1903.

THE STARS.—The positions of the principal constellations near the middle of the month at 9 P.M. are as follows:—

ZENITH . Perseus, Auriga (*Capella*).

SOUTH . Pleiades, Taurus, Orion, with Aries and Cetus towards the S.W., and *Procyon* and *Sirius* towards the S.E.

WEST . Pegasus, Andromeda, Aquarius and Pisces; Cygnus to the N.W.

EAST . Leo (*Regulus*) low down, Cancer, Gemini (*Castor* and *Pollux*) high up.

NORTH . Ursa Minor and Draco below *Polaris*, with Cassiopeia to the left and Ursa Major to the right.

Minima of Algol occur at convenient times on the 7th at 11.51 P.M., 10th at 8.40 P.M., 13th at 5.29 P.M., 28th at 1.34 A.M., and 30th at 10.23 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of December Problems.

No. 22.

Key-move.—1. P to B7.

If 1. . . . Kt to K2 (or R3),	2. Q to K8, etc.
1. . . . Kt to B3,	2. Q to B4ch, etc.
1. . . . K to K4,	2. Q to K8ch, etc.
1. . . . B to Kt7,	2. Q to B3ch, etc.

After 1. . . . B to B6 there is a *triple* continuation by 2. Q to B4ch, Q to B5ch, and Kt to Kt5ch.

No. 23.

Key-move.—1. B to Q5.

If 1. . . . R to Q6,	2. Q to QKt2, etc.
1. . . . P to K6 (or B to Q2),	2. Q × Rch, etc.
1. . . . R to QB6,	2. Kt × R, etc.
1. . . . R < P (or R to KR6),	2. Q to QKt2, etc.
1. . . . Kt to B5,	2. Q × R, etc.
1. . . . R to Kt6,	2. P × R, etc.
1. . . . R to Kt5,	2. R × R, etc.
1. . . . R to K6,	2. Q × R, etc.

There is a dual after 1. . . . B to Kt4, by 2. Q × Rch and Q to QKt2; and after 1. . . . R to QR6, by 2. Kt × R or Q to QKt2. G. Woodcock points out a pretty "try" by 1. Q to B7, B × Q (?), 2. Kt to B6ch, K to K3, 3. B to B8 mate.

No. 24.

Key-move.—1. Q to R6.

If 1. . . . K × P,	2. Q × QPch, etc.
1. . . . B × P,	2. Q to Rsqch, etc.
1. . . . P × P,	2. Q to R7ch, etc.
1. . . . Kt × Q,	2. Kt to K6ch, etc.
1. . . . Kt to Kt3,	2. Q × Ktch, etc.
1. . . . P to K6,	2. Kt to B3ch, etc.

SOLUTIONS received from W. Nash, 5, 6, 4; W. Jay, 4, 6, 4; G. Woodcock, 4, 4, 4; G. A. Forde (Capt.), 4, 4, 4; "Tamen," 4, 5, 4; C. Johnston, 4, 5, 4; "Looker-on," 5, 6, 4; J. W. Dawson, 5, 4, 4; Lieut.-Col. Damania, 4, 0, 4.

W. Jay.—Will you kindly send your address?

"*Tamen.*"—I have referred again to your solutions of the November problems, and find that your score (5, 4, 4) was correctly given. The only dual you pointed out in No. 19 (other than the short mate) was that after 1. . . . B × KtP. You did not give the dual in No. 20, and those in No. 21, according to the published rules, do not count. The faulty punctuation was, I think, a printer's error which escaped notice. Thanks for your reference to KNOWLEDGE of February, 1894. I am glad to find that the views therein expressed on the subject of dual short mates were in accord with the final decision given this year. The temporary decision given in July this year was certainly incorrect.

W. Nash.—Your first letter reached me safely. Thanks for your news. Please say from what date you would like your year's subscription to commence.

THE SOLUTION TOURNEY for 1902 is now ended. Subjoined are the scores of those who attempted every problem:—

"W. Jay"	120
"Looker-on"	116
W. Nash	112
J. W. Dawson ...	100
C. Johnston	100
G. Woodcock	90
"Tamen"	78

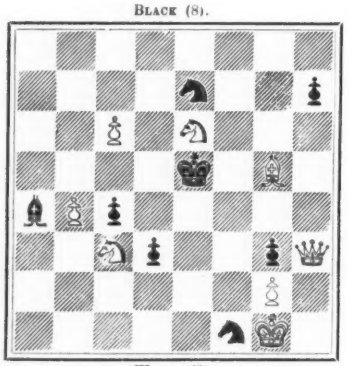
Any objections to the correctness of this score must be posted by January 10th. Failing this, Mr. "W. JAY" (W. J. N. Brown) becomes the first holder of the Challenge Trophy. Mr. Jay was second in the last Solution Tourney, after a tie for first place with Mr. Johnston. His score on this occasion shows how well he deserves his victory; out of a maximum of 121 he has obtained 120, the only point missed being for the dual in No. 22. The second prize (15s.) goes to "Looker-on" (G. J. Slater), who made a splendid uphill fight after losing three points in the first month. Mr. Nash, who obtains the third prize (KNOWLEDGE for twelve months) overlooked some duals in November, or would have been even nearer the others. Mr. Dawson solved every problem correctly, but was penalised once or twice for incorrect claims. Mr. Johnson missed two, but succeeded, nevertheless, in reaching the "century." Mr. Woodcock also failed on two occasions, and could, no doubt, have scored more for duals had he been so inclined. "Tamen's" score would have been considerably higher if his solutions had not been too late to count one month.

PROBLEMS.

No. 25.

"Inter pocula."

BLACK (8).



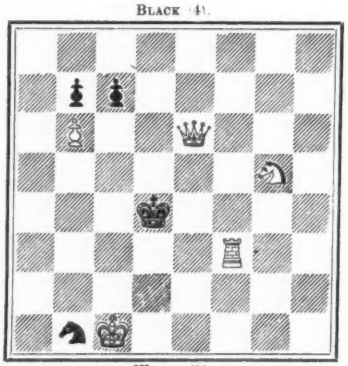
WHITE (8).

White mates in three moves.

No. 26.

"Ben trovato."

BLACK (4).



WHITE (5)

White mates in three moves.

The above are the last problems of the current Problem Tourney. It may be mentioned here that the order of publication has been decided by lot each month.

SOLUTION TOURNEY, 1903.

This year's Solution Tourney commences in the present number of KNOWLEDGE, and will continue till the end of the year. The winner will hold for twelve months the KNOWLEDGE Challenge Trophy. This will become the property of any solver who wins it three years in succession, or four years altogether. In the event of a tie, the previous holder will retain possession of the trophy; in that case, however, neither a win nor a loss will be scored to the holder.

The second prize will be 15s., and the third prize KNOWLEDGE for twelve months. In the event of ties for either or both of these, the ties shall be decided by a further trial of skill under new conditions, or the prizes divided at the discretion of the Chess Editor.

The problems published will be either three-move or two-move direct-mates, and not more than two will appear in any number. In the event of any problem being incorrectly printed, it will be cancelled and reprinted. Points will be awarded as follows:—

Two-move Problems.—Any one correct key, 2 points; a *second* solution, 1 point.

Three-move Problems.—Any one correct key, 4 points; a *second* solution, 2 points.

One point will be deducted for any one incorrect claim for a second solution. A correct claim of "no solution" will count as a correct key.

SPECIAL NOTE.—Duals will not score *after this month*, when the Tourney Problems come to an end. All solutions must bear postmark of the issuing office not later than the 10th of the same month.

CHESS INTELLIGENCE.

Another small tournament among the Parisian experts has just been concluded, M. Silbert on this occasion joining the competitors in the previous tourney, which was won by M. Janowsky. This time M. Taubenhaus succeeded in sharing the first and second places with M. Janowsky, their scores being 4½. M. Albin scored 4, and M. Silbert 1½. Herr von Scheve retired in the middle of the competition, his score at the time being 1½.

The British Chess Club being now, as a separate institution, defunct, the management of the Anglo-American Cable Match will in future be in the hands of the City of London Chess Club. The date of the match will depend on that of the conclusion of the Monte Carlo tournament. It is hoped that the transmission of the moves will be effected by means of wireless telegraphy.

All manuscripts should be addressed to the Editors of KNOWLEDGE, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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